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VOL. XLVI

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APRIL 1939

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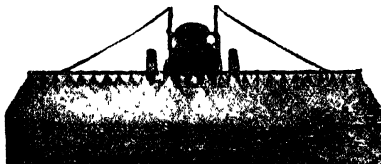
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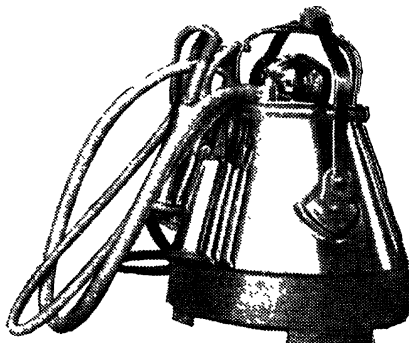
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Photo]

HEREFORD BULLOCKS

[F. C. Nicholas.

Including the Champion Bullock at Stafford Smithfield Fat Stock Show, 1938, which weighed 12½ cwt., and was sold for £32. Four of these Beasts took First Prize at the same Show and four others, also shown in this photograph, First Prize at Eccleshall Fat Stock Show, 1938. The property of our esteemed customer, A. Malpass, Esq., Lower Cowley Farm, Gnosall, Staffs. Fed on Bibby's High Carbohydrate "Cakelettes."

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THE JOURNAL OF THE MINISTRY OF AGRICULTURE

VOL. XLVI

No. 1

APRIL 1939

The "Journal"

With this issue, the JOURNAL of the Ministry of Agriculture commences its forty-sixth annual volume. Over so long a time, there have naturally been many changes, both in its form as well as in its contents. In its earlier period, the JOURNAL was probably of most value to the scientific staffs of county councils, to lecturers, etc., who found in it a means of keeping in touch with the Department and with agricultural educational and research work in the country. In view, however, of the spread of agricultural education and the almost universal extension of scientific methods to farming since the JOURNAL was first published, it is now possible to address a very much larger audience. The working farmer of to-day welcomes the opportunity of being kept in touch with recent developments, and the present JOURNAL, therefore, aims at disseminating to the general farming public the results of scientific research applied to agriculture, by means of articles which are informative, easy to read and of practical application. And since, to the practical man, the example of what other farmers are attempting is always of interest, provision is made to include in each issue articles by practical men. "Science and Practice" expresses the present purpose of the JOURNAL.

In compiling the JOURNAL month by month the Editor has been greatly assisted by a number of regular contributors who have dealt with such subjects as the problems of feeding, of manuring, or agricultural machinery, or the monthly operations on the farm. Most of these features will be continued. Dr. Charles Crowther, the distinguished Principal of Harper Adams Agricultural College, whose articles on animal feeding over the last three years have been much appreciated, has, however, been compelled to relinquish his series. To him, and to Dr. R. W. Wheldon, who is also discontinuing, the thanks of the JOURNAL and its readers are due. We have,

however, been fortunate to secure as a regular contributor Dr. Norman Wright, Director of the Hannah Dairy Research Institute, Ayr. Dr. Wright's series of articles, of which the first contribution, in conjunction with Dr. S. Morris, appears this month, on the feeding standards for farm animals, promises to be of exceptional interest and of practical value.

Not only have the contents of the JOURNAL undergone modification as circumstances required, but its appearance has also changed with the years. Hitherto, whatever the colour of the cover—green, brown or battleship grey—the general appearance has been unobtrusive, but an attempt is being made with this issue to bring the general format of the JOURNAL more into line with the other publications of the Department.

We rely on readers to co-operate with the Ministry in extending the usefulness of the JOURNAL as widely as possible. Advertisement, whatever form it takes, is not nearly so effective as personal recommendation. If readers would care to send to the Editor names and addresses of farmers who might be interested in the JOURNAL, steps will be taken to get in touch with them.

The Ministry's Leaflets and Bulletins

Reference may be made to another means of providing information and guidance for farmers, namely the publication of Advisory Leaflets and Bulletins.

The former now number nearly 300 and have been issued over many years. Their purpose is to give brief directions on particular subjects, such as disease control, cultivation methods, etc. In 1930, the need for more detailed publications led to the introduction of the series of Bulletins. Up to the present, well over one hundred of these have appeared, and the more recent issues, by their general format and attractive covers are interesting evidence of the progress that has been made in the presentation of official publications. The real demand that exists for publications of this character is demonstrated by their sales, which now total well over 500,000.

Several interesting new issues are in preparation, and among those that it is hoped to publish in the near future may be mentioned *Flowering Plants in Pots* (No. 112), the fourth in a series devoted to commercial flower production, *Rhubarb Cultivation* (No. 113), and *Diseases of Bulbs* (No. 117).

The Bulletins are not allowed to get out-of-date, and every

opportunity is taken to revise them as frequently as possible in accordance with the latest knowledge available. Among the revisions to be issued shortly is the tenth edition of No. 48, *Rations for Live Stock*, which is now in its fiftieth thousand, and whose author, Dr. Woodman, has also practically re-written No. 13, *Home-grown Feeding Stuffs*, a Bulletin that would be of particular value in the event of any failure in the maintenance of overseas supplies of animal feeding stuffs. Sir E. J. Russell has prepared a new edition of his excellent *Fertilizers in Modern Agriculture* (No. 28), in which he has incorporated the latest figures and results of investigations on this important subject.

A complete list of the Ministry's publications may be obtained free on application to the Ministry or to His Majesty's Stationery Office.

Specialist Advice for Farmers

Some farmers may be unaware of the facilities available under a State-aided service through which they may obtain specialist advice and assistance on their technical problems. The following note briefly recounts the organization of the service, its aims and its recent progress.

The service was introduced in 1910, and has grown since the War into a comprehensive service covering almost all branches of agricultural science and practice. In practically every county there is a county agricultural organizer appointed by the County Council. His staff normally includes members trained in dairying, poultry-keeping and horticulture.

These county officers provide a free and readily accessible advisory service for farmers on such questions as clean milk production and its allied difficulties, the establishment of a tuberculin-tested herd, the manuring of crops, the rationing of live stock, the management of poultry, the care and management of orchards and so forth. In effect they deal with the routine problems which daily confront the farmer and become more pressing with the intensification of production and the standardization of products, the wider use of machinery and the changes in policy and method necessary to meet economic conditions.

These men are not only acquainted with everyday agricultural practice by virtue of their duties but, by being in touch with both the work and the staff of the agricultural research stations and advisory centres, are kept well informed on the

results of recent investigations and experiments on agricultural and horticultural problems.

In addition to the county organizer and his staff, there is need for the consultant specialist. Each university, or university college, with a department of agriculture and, with some exceptions, each agricultural college, is an advisory centre serving a separate group of counties (a "province") and carrying a staff of advisory specialists who are specially qualified in a number of the many fundamental sciences which underlie the practice of agriculture. There are 13 centres in England and Wales at which specialist advisory staffs are stationed.

There are many agricultural and horticultural problems which can be investigated at these centres. For plant pests and diseases, entomologists and mycologists are available to deal with the troubles caused by insects and fungi and other micro-organisms of plants. Chemists investigate problems of soils, manures, animal feeding and feeding stuffs; economists deal with questions of farm accounts, farm management and agricultural economics in general. At most centres, also, there are veterinary investigation officers, who deal with animal diseases of general public interest in the province, e.g., epidemics, or cases of high and long-continued mortality in flocks or herds. There are also dairy bacteriologists, who carry out bacteriological examinations of milk and dairy produce and advise in cases of bacteriological troubles.

Advisory chemists must not be expected to carry out mere routine analyses of manures or feeding stuffs; in such matters they will usually refer the farmer to the county agricultural analyst. At the present moment, however, many farmers may be considering the advisability of applying lime or slag to their land; they are anxious to take advantage of the subsidy payment if the application of such fertilizers is necessary. They should write to the agricultural organizer, who will arrange for a sample of the soil to be analysed at the advisory centre and for the lime or slag requirement to be estimated.

Again, advisory economists cannot be expected to act as accountants or book-keepers to the farmers in their province, although they may elect to keep accounts in respect of farms which possess features of special interest.

The closest co-operation is maintained between all these specialist advisers, the research institutes, the universities and colleges, the county agricultural staffs and the Ministry. Such co-operation is very necessary, since the two sets of advisers

(the county staff and the provincial specialist advisers) act as links in the chain between the farm and the respective research institutes. Contact is maintained between the county agricultural staffs through conferences held at regular intervals.

Numerous instances could be quoted of successful investigation and effective treatment resulting from an approach to the specialist advisers and, in addition to the many individual cases dealt with by them, there are continuous investigations in which a number of centres collaborate. These cover major problems which most farmers are liable to encounter, such as the eradication of tuberculosis and contagious abortion in cattle, "grey speck" in oats and "take all" in wheat, eelworm and other pests of the potato; milk costs and farm management investigations have already been mentioned; soil survey work is carried out under a number of advisory chemists in accordance with a closely co-ordinated scheme.

These centres also assist in the designing and co-ordination of series of experiments conducted in different counties throughout their area, investigating by trial, for example, the method of cultivation, the manuring and the most suitable seed mixtures for the laying down of grass land—problems common in character but needing variation in treatment according to climatic, soil and other factors.

Further details of the advisory service are given in Form No. 705/T.G., obtainable free, and post free, from the Ministry.

POULTRY PROBLEMS

R. E. LOUCH AND W. B. MERCER,
Cheshire School of Agriculture, Reaseheath

The poultry farm at Reaseheath was established in 1920 as an independent unit, carrying a laying stock of 600 to 800 birds. Its early history was quite a happy one. It was used primarily for teaching and demonstration purposes; small flocks of 7 or 8 breeds were maintained, a variety of equipment was introduced and tested out; considerable trade in sittings, day old chicks and stock birds was developed, and, financially, the farm generally "ticked over." The system of stock management changed a good deal from time to time as the popularity of breeds waxed and waned, sex linkage developed, and the nature of available equipment and housing changed. Dry mashes gradually displaced wet mash and grain for rearing purposes, a battery brooder was introduced, and then the device which some humorist christened a "sun parlour."

In the early 'thirties, things began to go wrong. Mortality rates began to rise. Parasites with fearsome names began to take fearsome toll of young stock. Tuberculosis became prevalent amongst the older birds; *post mortems* of adults often showed tumours; now and again a case suspiciously resembling fowl paralysis occurred. Culling of laying pullets and even of year-old birds became an almost farcical procedure since by no known test could we pick out birds with a reasonable expectation of life. The general "quality" of our stock seemed curiously to fall away and egg yields fell also.

So in 1933 a drastic overhaul of methods was undertaken. A small number of birds in the existing flocks were selected as foundation breeding stock and the remainder were disposed of. New flocks, limited this time to Rhode Island Reds and Brown Leghorns, with a few Light Sussex for sex-linked work were raised on virgin seeds and put out as adults on another field newly sown from arable, or transferred to intensive

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houses. Arrangements were made for regular resting of all ground used for poultry. From this date onwards all breeding stock has been bred from hens two years old or over; cocks have been used in preference to cockerels; in 1936 the system of rearing was changed back to that employed in the days before intensive brooding was thought of.

The net effect of all these changes on the health, output and longevity of the flocks has been marked. Moreover, the improvement promises to be cumulative. The measures taken have been so numerous, their effects so interlocked, that it is not easy to assess their respective significances. As, however, rather extensive records have been kept throughout, it is now possible to make at any rate a shrewd guess as to effect of each.

It will be convenient to discuss these measures under the three heads of hygiene, rearing and breeding.

Hygiene. Intensive stocking of land with any kind of animal is liable to result in an accumulation of its natural parasites. Indeed, once a parasite of any kind gains admission to the fold, its multiplication would seem to be in the nature of a mathematical certainty. If a worm or a coccidium has to pass through a fowl's body to complete its life cycle, its chances of multiplication are greatest when fowls are thick on the ground. On this farm, fowls had been run pretty thickly for a dozen years. Trouble from parasites was therefore to be expected. But there were two unusual and disconcerting features about the situation. In the first place, although coccidia were the first serious trouble and for several years remained a constant menace, other pests sprang up, aiding and abetting, or even displacing them in the van of the invading forces. A tapeworm *Davainea* began to appear alongside coccidia; often from a *post mortem* it was difficult to say which was the primary and which the secondary parasite. This worm is said to pass part of its life cycle in the body of a slug and the remainder in the fowl's body. Following a year in which it had been prevalent among half-grown stock, we reared chicks entirely on an adjoining clover root—that is to say on land which had never before had chickens on it. Yet the chicks developed tapeworms abundantly; it looked as though slugs from the previous year's ground had become infected and then marched across on to the new land in order to get themselves eaten by chickens.

POULTRY PROBLEMS

We did not, however, follow up this interesting problem of mass migration; our attention was distracted by other things. Deaths from tumours tended to increase and a round worm *Capillaria* appeared—apparently out of the blue. Even more disturbing was the appearance of duodenal coccidiosis—and a bad outbreak at that—in a batch of chickens which had been reared entirely intensively.

These experiences led us gradually to a change of front. We had started out with the ideal in our minds of disease-and-pest-free stock. Theoretically, if the parasites of poultry are specific to poultry, it should only be necessary to hatch eggs in a clean incubator and to rear the chicks on virgin land in order to achieve a pest-free stock. That is the principle upon which tuberculosis-free herds of cattle are maintained. The principle appears to hold good for tuberculosis-free flocks—we have found but one tubercular bird on the farm in the past four years—but it seems to break down as regards intestinal parasites. Either the latter are not specific to poultry but infect equally other kinds of birds, or they are so easily transferred from field to field that for all practical purposes they may be regarded as ubiquitous.

Gradually, therefore, we have dropped the conception of isolation, abandoned as hopeless the task of shielding stock from the possibility of infection, and aimed instead at the prevention of *mass infection*; that is to say, at providing conditions under which only small concentrations of parasites are likely to occur at any one time or place. This is a much more limited objective, though from the point of view of land management its implications are identical with those of the more ambitious object. Latterly we have indeed come to believe that a few parasites in a bird are of no great consequence to its health one way or the other.

LAND MANAGEMENT. To avoid accumulation of parasites, it is plainly necessary either to spread the birds very thinly over the land, or in some way to rotate them so that the parasites they have voided on any given patch may be dispersed by natural forces before they return to it. We adopted the second alternative.

In 1934, a line of breeding-houses was erected down the middle of a six-acre field of new grass. On one side of them, pens were wired off, and the remainder of the half-field was set apart for folders containing pullets. Next year the wire was taken up and re-erected on the other side of the houses,

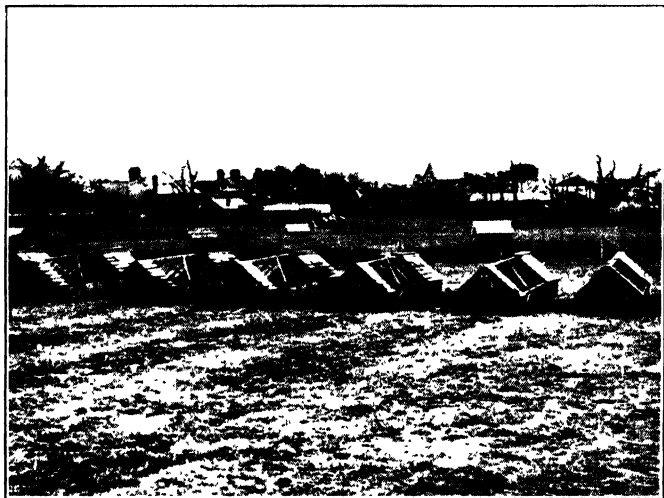


FIG. 1. Folding units and rearing ground



FIG. 2. Breeding pens



FIG. 3 Cross-bred Galloways on poultry ground

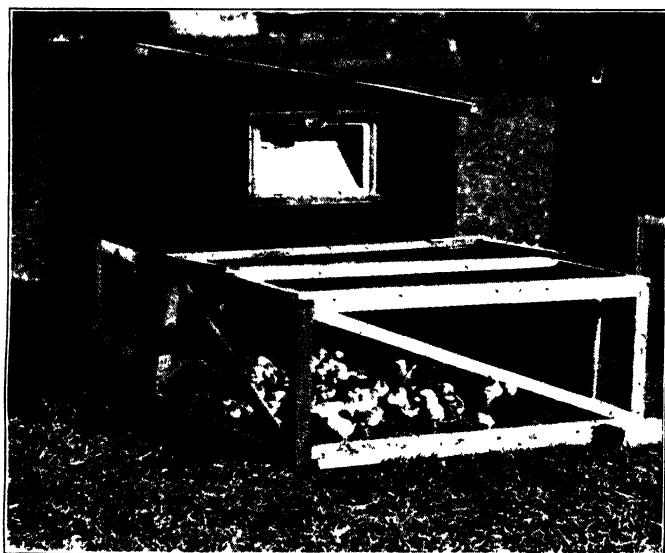


FIG. 4 Baby Chicks at grass

POULTRY PROBLEMS

the folders were moved round, and the whole of the vacated land was grazed by cattle. The original arrangement was restored in the third year; and so on. By this means both breeding pen and folder land has been completely clear of poultry in alternate years, the effect being to reduce the stocking to the equivalent of 125 birds per acre on the breeding land and about 35 birds per acre on the pullet land.

The folders employed measure 16 ft. \times 4 ft. 6 in. In 1933, these devices were just coming into general use and there was no sort of agreement as to dimensions or design. After much trial and tinkering we achieved in our own workshops a design which seemed suitable for our purpose and had a dozen made to pattern.

They fulfil admirably the object of providing birds with a continuous change of pasturage but, like most of their kind, have not proved particularly popular with the folks who have to work them. Fitted with trapnests, they entail a great deal of kneeling, and largely on account of the labour involved, we have found it expedient to limit trapnesting of folded birds to the three autumn months.

We have endeavoured to avoid rearing chicks on the same ground for more than two years in succession, and to this end have set apart two fields, each of about 3 acres, which could be put under the plough when not needed for chicks. After some little experimentation we have arrived at a rotation for this land of kale—silage with seeds—seeds and chicks—seeds and chicks. In each year, therefore, the farm now has 6 acres of temporary grass—3 on the rearing field and 3 on the "fallow" portion of the pullet field—plus some pickings around the folders and in the breeding pens.

A good deal of attention has been paid to grass control. Geese in the breeding pens, and ewes with lambs are employed to some extent; and in good grass years the mowing machine is sometimes used to secure a small cut of hay. In the main, however, we have relied on cross-bred Galloway heifers, of which 6-8 are bought each autumn and fattened off in the succeeding summer. They are quiet, neighbourly creatures. On one point, however, they do insist—there must at all times and in all places be plenty of grazing. Given good pasturage a spider web will keep them at home. Let the pasturage run short, an elephant fence is needed.

The land, it should be said, was, and is, in good heart, and the rainfall averages 30 in. per annum. Even so, the tem-

POULTRY PROBLEMS

porary grass has thriven beyond our expectations. It will be observed that it is put down in a silage crop—usually oats with a few peas. This is cut as it shoots in June, and again, if necessary, a month later. Cattle are admitted as soon as the grass reaches grazable length, and as a rule a close sole results by October. In the succeeding year it has the appearance of a three-year-old turf, the presence of red clover alone betraying its youth. Its productivity is beyond question, though not very easy to calculate exactly. It can be put roughly at the keep of one 8 cwt. heifer for a complete year on $1\frac{1}{2}$ acres, plus the poultry. Even 500 growing chicks per acre make no serious impression on it. It must, of course, be allowed that the farm is no longer, strictly speaking, a poultry farm. Neglecting intensively housed stock, the total area of land—12 acres—now carries but 400 adult birds and an average summer stock of 1,200 youngsters.

It will be convenient to consider the apparent effect of temporary grass on the health of the stock in a later section, and meantime to interpolate a few words on intensive housing.

INTENSIVE HOUSING. Theoretically, intensive housing should give the poultry keeper an excellent control of parasites and epidemic diseases. In 1933, we commenced a study of intensive methods of management, using pullets derived from the folders, i.e., pullet-bred pullets. Our experiences may here be described, though they have but little bearing on the main history. They fall under two heads:—

Isolation Cabins. A series of ten isolation cabins with wire mesh annexes of equal floor space were erected to our design. The cabin measured 7 ft. 6 in. \times 7 ft. \times 6 ft., and was freely lighted and ventilated. It was designed to hold 16 birds, but has been tried with numbers varying from 6 to 20. For three successive years these houses were stocked with pullets in the autumn, and every nutritional factor we could think of was provided for. Fecundity, though variable, was normal, but the death rate from normal causes showed no signs of falling below that of pens managed in the usual way, and vices such as feather plucking and vent picking were a constant anxiety. The aggregate losses from these houses were, therefore, higher than from semi-intensive houses, the figures sometimes rising to 40 per cent. in six months.

Laying Houses. Three ordinary laying houses of varying design, with an aggregate capacity of about 150 birds, were also stocked with pullets kept permanently inside. Results

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here, though no better than in houses with runs, were on the whole better than in the isolation cabins owing to the fact that there was less loss from vices. Certain lots, indeed, lived through their pullet year without once displaying serious vice. It was difficult to escape the conclusion that the prime causes of vice were much the same in fowls as in humans—idleness and evil company. Window space appeared in no wise to influence the matter; nutrition had little effect; and the differences between houses were attributable either to the mere accident of the presence of a ring-leader, or to the chances of escape of attacked birds. In this latter respect our new houses were worse than the older laying-houses merely because they were smaller.

Since intensive housing seemed to offer no contribution to our main problem of lowering death rates, we abandoned this particular project in 1936.

RESTRICTED GRAZING PENS. As a modification we have now added a cinder yard and a tiny grass outrun to each of the intensive houses. In theory, the birds spend the greater part of the day in active contentment on the cinders, and cheerfully accept a limited period of grazing before turning in for the night. In fact they seem to hang about on the cinder run with a dejected air waiting for opening time; and when they are at last admitted devour as much grass in ten minutes as one would expect a normal hen to consume in ten hours. The system avoids the vices incidental to intensive housing and apparently allows of normal fecundity, but it is not otherwise promising; it remains to be seen whether the parasite population of the runs can be kept down below the danger limit.

Rearing Methods. During the period 1920-30 we had gradually shifted from natural or semi-natural, to more intensive methods of rearing, and by 1933 practically all our chicks were being passed through a battery brooder for two to four weeks, then through small brooder houses with sun parlours for four to six weeks. They were, therefore, eight to ten weeks old before they were allowed out on to grass. From 1925 onwards we had relied mainly on all-dry-mash feeding. In the light of after events it has been of interest to look up notes which we made during the period of these changes. We find, for instance, that in 1925 a batch of chicks was reared for twelve weeks on dry mash only,

POULTRY PROBLEMS

being kept intensively for the first five weeks. We observed that mortality in the first twelve weeks was only 3.3 per cent., but that the chicks' legs were notably pale until they got on to grass. When the battery brooder was first introduced, chicks were confined therein for four weeks, but after one year's experience we reduced the period to three weeks, then to two. In 1931 we noted unusually large losses from impacted gizzards, which we thought might be due to all-dry-mash feeding.

Our main concern, however, when an overhaul of our methods was started in 1933, was disease. The outstanding need seemed to be avoidance of infection from the ground; and accordingly for some years we continued to rear intensively to 8 weeks. From this age onwards, the chicks were provided each year with a patch of clean turf—new seeds if available or at least land which had carried no poultry for a year or two.

Comparative figures for 5 years may be summarized thus:—

	<i>Hatched</i>	<i>Mortality*</i> (%)	
1931 ..	4,692	37	Old land
1932 ..	4,800	26	" "
1933 ..	2,991	21	New land
1934 ..	3,971	27	" "
1935 ..	4,391	31	Old land rested 1933 and 1934

This was not very encouraging. It was clear that clean land was no guarantee of healthy stock. Indeed, coccidiosis and tapeworms were as troublesome in 1935 as in any previous year. A small test carried out in this year, however, encouraged us to revert to old-fashioned methods. Two batches, each of 50 comparable chicks, were marked at birth; one lot was reared intensively as usual, the other was run on grass from a week old onwards. There were fewer losses in the latter lot than in the former. In this year, dry-mash feeding was restricted, with apparently good effect on the birds' ranging capacity.

About this period we repeatedly noticed in the course of advisory work that losses appeared to be lowest on farms on which chicks were turned out at an early period of life. We decided, therefore, to revert to open-air rearing, wet-mash and grain.

There was, indeed, much about the history of the farm which

* See footnote on following page.

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suggested that parasitism was not the primary cause of our troubles; or, to put the matter in a more positive way, our experiences were consistent with the theory that intensive rearing methods were producing "over-grown" birds with a digestive system in some way defective, birds with abnormally low powers of resistance to parasites. Moreover, as already explained, we had found it quite impracticable to isolate chicks from their parasites; there was nothing left for it but to try to strengthen their defences.

For the past three seasons the battery brooder has not been used; chicks have been transferred from the incubator to small houses with a lamp, and allowed to run out on to grass as soon as they could run at all, the only protection afforded being a framework of netting to keep them within bounds, and feeding has consisted of grain and wet-mash with access to dry-mash for restricted periods of the day. Results have been as follows:—

		<i>Hatched</i>	<i>Mortality*</i> (%)	
1936	..	3,936	20	1935 land
1937	..	4,303	7	Babies on new seeds. Growers on 1936 land
1938	..	4,630	8	New land

The results are not absolutely consistent, for, as will be observed, losses amounting to 20 per cent. occurred in 1936. It should, however, be added that culling in that year was exceptionally drastic; and it is quite possible that the old ground used in that year was, in fact, infested with parasites from the previous year. The fact that new land for the babies in 1937 gave better results may be significant. It is just possible, too, that the composition of the mash in 1937 and 1938 may account in part for the improvement. In the former year a new mash containing 10 per cent. dried skim milk and 10 per cent. fish meal was introduced.

Upon the whole we see no reason to doubt that the most obvious deduction is likely to be the correct one, viz., that outdoor rearing has resulted in a much healthier stock than we got during the previous five or six years when rearing up

* The mortality figure has been arrived at by adding up the numbers of dead and missing, and then calculating as a percentage of the number hatched. As a certain percentage of the stock are sold during the process of rearing each year, this method tends to understate the losses; and as the numbers sold and dates of sale vary slightly, exact comparison of year to year results is not possible.

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to eight weeks on wire and wooden floors. We cannot profess to explain why.

We may add that even the figures set out above do not do full justice to the old-fashioned methods to which we have reverted. The mortality figures for 1937 and 1938 include a number of birds which died from picking up sheep's wool and a few which fell to Reynard's privy paw. Moreover, no figures can express the vigour and vitality of the broods of these years. We have repeatedly observed in the course of county work that high rearing mortality is followed by high wastage throughout the pullet year, particularly in the critical months of autumn. Conversely, vigorous young stock usually result in pullet flocks with low mortality rates. We believe that the improvement in our pullet flocks to be described is referable in great measure to the vitality of the youngsters.

Breeding. Improvement of a flock by the adoption of a specific breeding policy is a problem of a different order altogether from that presented by hygiene or nurture. In the latter field mass results more or less in conformity with one another may be expected from mass action. But breeding is an affair of individuals; in the present state of our knowledge, flatly contradictory results may easily result from the mating of apparently similar pairs. At the least, variable and inconclusive results may be anticipated. A breeding policy is, in fact, as much a policy of faith as of reason.

We decided to breed from old birds in the belief that the progeny of long-lived parents tend to live longer than the progeny of short-lived parents. The theory is, we believe, actuarially sound in the case of human beings and has for years been accepted as sound in the poultry industry, though it is only recently that concrete evidence to that effect has been forthcoming.

Breeding from old birds involves, of course, an immediate sacrifice of income, since the annual egg yield of a second-year hen is not normally more than two-thirds that of a pullet, her yield in each subsequent year falling continuously. Moreover, fertility in matings between old birds is generally also low—though there are many exceptions to this rule.

Nevertheless, if liveability be regarded as the prime consideration in breeding, and other qualities of secondary consequence only, there seems good reason to retain birds in the breeding pens as long as they remain capable of breeding.

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With annual wastages of 30-35 per cent. this would seem to mean that a policy of breeding from old birds involves ultimately pens made up of second, third and fourth year hens in the proportion of 8:3:1, or something of that kind, headed by a male two years old or over. This means that each year about 8 selected hens and a new male must be found.

SELECTION OF FEMALES. Plainly the success or otherwise of the policy hangs on the selection of the birds which find their way into the breeding pen. Dame Nature can be trusted to do a great part of the selection during the first two years of life. In theory there are opportunities for the breeder to superimpose cullings through sieves of progressively finer mesh, viz:—

SELECTION OF PULLETS FROM THE BEST HEN FAMILIES.

SELECTION OF YEARLINGS ON PULLET RECORDS.

**SELECTION OF BREEDERS ON PROGENY
RECORDS OF YEARLINGS.**

Though we have rather painfully accumulated the records necessary for the application of such tests, we have not, as yet, been able to make much use of them. As a rule, the numbers available have been just large enough to allow of some selection of pullets according to family, and of yearlings according to the pullet year performance, but individual handling has had to be the chief factor deciding the matter.

Our general arrangement has been to set apart in the folders sufficient space to accommodate about a score of pullets from each breeding pen; and from the survivors at the year end some 8-10 individuals have been selected to go forward as breeding recruits.

A serious attempt has, however, been made to apply progeny tests in selecting the males to mate with them.

PROGENY TESTING OF MALES. Ideally, progeny testing should be carried out in such a manner that the best combinations of the individuals available are discovered—for it has to be admitted that any test mating holds good for that particular pair of birds only. Again, however, one has to be content in practice with something very far short of the ideal, and to use the progeny test merely as a rough index of the cockerel's capacity, by mating him to a number of females.

We commenced progeny testing in 1935, arranging in each year to test six cockerels of each breed. Pullets from selected

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hens in the breeding pens were distributed evenly among the folds in order to make the test of the cockerels as fair as possible; about 100 eggs by each male were pedigree hatched, and all chicks were reared together; some 20 of the female progeny were then placed in the small intensive houses described on page 10, so that their autumn production and mortality rate could be discovered.

For the first two years the test failed in its main purpose, as half of the males died in their first year, and of those that were retained half died or proved infertile in their second year. Further, the evidence for the surviving males was seldom wholly good or wholly bad—it generally left us with a choice between alternative evils. Particulars of the three R.I.R. males surviving the 1936 test may be cited:—

R.I.R. 1936 PROGENY TEST				
Cockerel	.. ..	GP 35	GP 45	F 35
Eggs set	.. ..	121	99	102
Hatchability (per cent.)	.. ..	52	69	76
Rearability (per cent.)	.. ..	76	54	58
3 months' yield	.. ..	35	16	24
3 months' mortality (per cent.)	.. ..	22	36	25

In the 1938 tests, however, we were more fortunate, 5 birds out of 6 in the one breed, and 4 out of 6 in the other, coming through the test, and the performances of their progenies showing considerable variation:—

<i>Brown Leghorn</i>				<i>R.I.R.</i>	
Cockerel	.. ..	A	B	C	D
Fertility (per cent.)	.. ..	93	95	94	99
Hatchability (per cent.)	.. ..	68	67	48	76
Rearability (per cent.)	.. ..	76	93	88	94
3 months' yield	.. ..	19	29	31	28
3 months' mortality (per cent.)	.. ..	5	5	6	—

Experience alone can prove whether the apparent merits of B and D will be demonstrated in later matings.

BREEDING RESULTS. Since every breeder must perforce be guided by his own results, be they ever so scanty, we have put together the figures from our R.I.R. flocks. The performances of hens and pullets as breeders are set forth in the following table:—

BREEDING PENS					PULLET PENS				
	Eggs Set	Hatch-ability	Rear-ability	Mortality* Oct.—Dec.	Eggs Set	Hatch-ability	Rear-ability	Mortality* Oct.—Dec.	
		%	%	%		%	%	%	
1936	.. 321	41	71	9	520	60	62	30	
1937	.. 446	65	90	5	1,242	62	89	5	
1938	.. 459	55	89	3	621	62	92	3	

* Based on 70-100 selected females.

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In examining these figures, it is imperative to remember that the progenies of the hens have been placed on good grass in fold houses, while the pullets derived from pullets have been housed intensively.

It seems evident that the method of rearing the chicks has influenced results more than the method of breeding—the rearability and autumn mortality figures are, in fact, primarily a repetition and continuation of the results already set forth in the section dealing with rearing. In the one year in which there was any material difference between the respective progenies, however, the difference was certainly in favour of the hens.

Aggregate Effect of Changes in Methods. The total effect of the several changes in method introduced during the past five years can perhaps be judged most effectively from the performances of the pullet flocks derived from old birds in the breeding pens. Each of these flocks averages about 70 birds. Their performances are summarized in the following table:—

<i>Year Hatched</i>	R.I.R.		BROWN LEGHORNS	
	<i>Average Yield Oct.-Dec.</i>	<i>Mortality* 12 months</i>	<i>Average Yield Oct.-Dec.</i>	<i>Mortality* 12 months</i>
1935	29·7	44·1	31·5	23·1
1936	33·3	32·0	33·3	14·5
1937	40·5	14·0	28·5	11·1
1938	51·5	†	31·2	‡

* Actual deaths + non-saleable culls.
† Mortality, Oct. 1–Mar. 20. = 4·2 per cent.
‡ " " " " = 1·4 "

It is evident from these figures that, at the outset, the Rhode Island Red was much the poorer flock of the two; the mortality rate was nearly double that of the Leghorns, and (probably in consequence) the average autumn yield was very low. Both flocks show marked improvement in liveability.

Again, it seems probable that the lowering of the mortality rate is to be explained chiefly by the change in rearing methods described in an earlier page. The continuity of the improvement, however, does suggest that the practice of breeding from old birds may be also bearing fruit.

None of the deaths in the pullet flocks during the past two years has been traceable to parasites. We conclude, therefore, that the hygienic measures taken have contributed their quota to the results.

CALF REARING

N. V. HEWISON,

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Calf rearing on a milk-selling farm has always been a problem. To keep up anything like a regular supply of milk throughout the year a large proportion of the cows in the herd must be autumn and winter calvers. The price obtained for the milk at this time of the year is at its highest, and therefore expensive for calf rearing. With the expansion of tuberculin tested and attested herds the need for rearing one's own replacements for the herd has become almost a necessity. The demand to-day is for disease-free stock, and the prices realized for such stock is evidence of this ready demand. The self-contained herd, is, from many points of view, the aim to-day. With milk at its present price, a calf reared on fresh new milk starts life with a bloom that no milk substitute that I know of will produce, but at a cost that, for ordinary commercial cattle at any rate, is much too high.

With calf-rearing generally, I consider that much trouble and sometimes total loss is incurred by over-feeding the calf during the first fortnight of its life. A calf, if reared in the natural way, will take its food from the cow in small quantities. In rearing a calf "on the bucket," large quantities of milk or milk substitute fed in the early stages will quickly upset the calf's stomach. It is well to bear this in mind, and to dilute the milk or milk substitute for the first few days.

Our method of calf rearing for a number of years has been to leave the calf on the cow for three days. After this, the calf is put on to whole dried milk powder fed in liquid form. The milk powder* is purchased in $\frac{1}{2}$ cwt. lots and is fed to the calves, beginning with $\frac{1}{2}$ lb. each per day and increasing this quantity up to 1 lb. per day, fed twice daily, by the time the calf is a fortnight old. This amount of 1 lb. each per day is not exceeded. As the calf grows and requires more

* The percentage chemical composition of the milk powder fed is : butter fat, 15 ; albuminoids (casein), 27 ; lactose (milk sugar), 47.

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food, concentrates and hay are given. The preparation of the milk powder is quite simple, no cooking being required. Sufficient warm water to make up the dried milk to half a gallon at each feed is all that is necessary. This is then fed to the calf at the *right temperature*, i.e., blood heat. Temperature is important, as food given too hot or too cold will quickly upset the calf at this tender age. The cost of the milk powder feed, when re-constituted, worked out at 6d. per gal. The dried milk is discontinued when the calf is ten weeks old. By this time the calf should be eating at least 1½ lb. concentrated food and 2-3 lb. hay each day.

From the age of two weeks, the calf should have access to clean water. It is important to see that this water supply is fresh and that the trough is emptied and cleaned out each day.

After weaning (at ten weeks old), the maximum amount of concentrates* fed is 3 lb. each per day and 5 lb. hay. The consumption of these amounts of food is reached when the calves are approaching 3 months of age. In addition, a few pounds of fingered roots or ensilage are given. Barley straw is available *ad lib*.

Most of our calves are reared during the autumn and winter and these calves are housed until the end of May, when they are turned into a field, with a partly covered yard to run into for shade or shelter. By this time of the year the nights are getting short and the temperature does not fall very low, consequently, the calves are not likely to suffer any hardships on this score. On being turned out to grass, the concentrates are continued, for a time at least, at the rate of 2 lb. each per day. Calves that have been housed need, of course, to be introduced gradually to freedom out-of-doors, otherwise in their excitement they may race about and become over-heated. In any case some time will elapse before they settle down to steady grazing. This makes it important that some concentrates should be fed, otherwise they loose flesh.

From this time onwards these calves (heifers) do not receive any hay until they come back into the herd as first calvers at 2½-3 years old. During their second winter they are grazing, with a yard to run into, and receive barley straw, *ad lib.*, ensilage or roots and 1-2 lb. of concentrates each per

* The type of concentrates used may be indicated as follows: Equal parts linseed cake, crushed oats or flaked maize, and bran, plus 10 per cent. white-fish meal.

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day. In their third winter they are run out, having no yard or shed to go into, and receive barley straw or second-quality hay, *ad lib.*, roots and concentrates. This out-wintering of young stock is carried out for two reasons. We consider we are rearing hardier and healthier animals, and rearing them more cheaply than when yarded all the winter.

To return to calf rearing up to three months old, there are several points in the management which need strict attention. First, cleanliness; this applies to the house the calf is born and reared in, the bucket it drinks out of, the manger and water supply. It is just as important to wash and sterilize the bucket as the utensils which are used in the milking shed. The housing should be light and airy (not draughty) and warm. If possible, it is well to arrange the housing so that the young calves can run out into an uncovered yard facing south. Calves quickly take advantage of sunshine when given the opportunity. Good drainage of the house is necessary, and plenty of clean dry straw should be provided for litter. The closed dark building so often associated with calf rearing is to be discouraged. As each calf is born we make a practice of dressing the navel with a strong phenolated solution of iodine. This dressing quickly dries up the navel, which, if it does not receive this attention, is an open wound for a few days, through which disease may gain admittance. If there is any doubt about the cleanliness of the calving box, it is considered better to let the cow calve out in the field, as there is less likelihood of the calf picking up disease in the field than in a dirty box or building.

Finally, I would like to stress the importance of attention to details in the early stages of the calf's life. The food must be given in the right amounts, increasing gradually, at right temperature and at regular intervals.

FEEDING STANDARDS FOR FARM ANIMALS: I. THE DRY MATTER REQUIREMENTS

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It is clear that, in formulating any scientific feeding standards for farm animals (for example, standards based on the energy or protein content of the ration), primary consideration must be given to the capacity or appetite of the animal for the food offered. In the present series of articles on feeding standards it is natural, therefore, to deal first with the total amount of food required, a figure which is usually expressed in terms of the total dry matter content of the ration. It is to the late Professor T. B. Wood that we owe the recognition of the importance of capacity or appetite in our feeding standards, and in the Ministry's Bulletin prepared by him (the first edition of which was issued in 1920) concrete figures are given for the requirements of the various classes of live stock.* Examination of these figures shows that, while there are individual variations due to differences in maturity and level of live weight, the requirements for dry matter for all classes of live stock fall roughly between 0.40 and 0.55 oz. per lb. of body weight. This would entail a daily dry matter intake of about 25-35 lb. per 1,000 lb. live weight for cattle, and a weekly intake of about 18-25 lb. per 100 lb. live weight for sheep, goats and pigs.

For animals of average productive capacity these standards are unlikely to be exceeded if the rations are based on the recognized requirements of energy and protein. A 1,000 lb. cow giving 4 gal. of milk per day would, for example, require only 14-16 lb. of concentrates for milk production, and this would provide an ample margin of dry matter to allow for the feeding of the appropriate quantity of coarser foods usually employed in the maintenance ration. With exceptionally high-producing stock there appears, however, to be a real risk that the animal's capacity for food might act as a limiting factor, or alternatively that digestive disturbances might be caused by overloading the stomach. For example, a cow

* *Rations for Live Stock.* T. B. Wood and H. E. Woodman, Bulletin No. 48 of the Ministry of Agriculture. Tenth Edition now in preparation.

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giving, say, 8-9 gal. of milk per day would require between 25 and 30 lb. of concentrates for milk production alone, and (on the basis of a maximum total dry matter intake of about 32-35 lb.) this would appear to leave entirely inadequate space for the necessary maintenance ration. It seems desirable, therefore, to re-examine in this article the whole question of the dry matter requirement, and to see how far recent investigations enable existing standards to be modified or re-interpreted.

Capacity of the Stomach. As far as actual capacity for food is concerned, it is unlikely that serious overloading of the stomach would normally be encountered in either growing or fattening stock, unless these were to be unduly forced. The maximum economic rates of growth and fattening entail far less intensive feeding than is necessary for high milk production, where the productive capacity has been phenomenally raised by improved methods of breeding and selection. For practical purposes it therefore seems justifiable to limit consideration of the actual stomach capacity to high milk-yielding stock, viz., to dairy cattle and milking goats. Scientific information regarding the food requirements of high milk-yielding goats is, unfortunately, not available, but it may be assumed that the same general considerations apply to goats as to dairy cows.

In the ruminant the stomach occupies about three-fourths of the abdominal cavity, the actual capacity varying with the age and size of the animal. As far as cattle are concerned, small animals have been found to have a stomach capacity of 25-30 gal., medium-sized animals of 30-40 gal., and large animals of 40-60 gal. The rumen, or paunch, which accounts for about 80 per cent. of the total stomach capacity, is therefore capable of containing very large quantities of food. If, for example, we assume that roughly half the available volume of the rumen is occupied by ingested food (the remaining half being left empty to allow for proper mixing of the rumen contents) and that such food *as found in the stomach* (a point which will be dealt with later) contains roughly 85 per cent. of moisture, the dry matter capacity of the dairy cow may be expected to vary from about 18-45 lb. This may appear to allow for excessively wide variations in dry matter intake, but the figures are borne out by the results of tests made by the authors in which the rumen contents have been

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actually weighed *post mortem*, and also by investigations undertaken by such workers as Schalk and Amadon of North Dakota, in which access has been obtained to the rumen of the living animal by means of a permanent fistula. Such methods show that the total weight of rumen contents may vary from roughly 100-250 lb. Moreover, the existence of such wide variations in the capacity of the ruminant stomach also receives indirect support from the results of a recent co-operative investigation sponsored by the U.S.A. Department of Agriculture. This investigation entailed a detailed study of the conformation of a large number of dairy cows in an attempt to relate body form to actual milk production. The investigation included a *post mortem* study of the size of the various internal organs, and although the capacity of the rumen was not directly measured, its volume can be indirectly calculated from the empty paunch weight as well as from certain body measurements. Such calculations indicate that the average capacity of the rumen of large Friesian cows (14 cwt. live weight) was roughly twice that of small Jerseys (7 cwt. live weight), while the figure for an average group of Ayrshires (10 cwt. live weight) fell intermediately. While these figures referred to the *average* value for selected groups, it may be noted that in extreme instances there was practically a three-fold difference in rumen volume between the smallest and largest animals.

What are the general conclusions which can be drawn from the above facts? In *Rations for Live Stock* the only guide to the capacity or appetite of cattle of varying live weight are the standards laid down for fattening cattle. Such standards apply to animals which have a markedly different conformation from that of the typical dairy cow. Moreover, these standards are in any event ultimately based on the maintenance requirements at different live weights (measured in terms of energy) and bear no necessary relationship to the actual capacity (i.e., the volume) of the rumen. Thus the daily dry matter requirement of an animal of 1,000 lb. live weight is given as only 22 lb. It is true that in this publication, as well as in the companion Bulletin entitled *The Feeding of Dairy Cows*,* a much higher figure (32-35 lb.) is suggested for dairy stock, but no clear indication is given of the extent to which this standard can be varied according to

* *The Feeding of Dairy Cows*. J. Mackintosh. Bulletin No. 42 of the Ministry of Agriculture. H.M. Stationery Office. Price 9d. (by post 11d.)

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live weight or to suit the requirements of the individual. The evidence already quoted permits us, however, to formulate two tentative conclusions regarding the dry matter intake of milking stock.

The first conclusion is that the volume of the rumen appears to vary directly with the live weight of the animal, *and that the capacity for dry matter can therefore be taken as being directly proportional to the live weight.* Thus, if 30-35 lb. of dry matter be taken as the normal capacity of animals of 1,000 lb. live weight, such as medium-sized Ayrshires and Dairy Shorthorns (and practical experience indicates that this constitutes a reasonable standard), the quantity could be safely raised to 45-50 lb. for an exceptionally large animal of 1,500 lb. live weight, such as a South Devon or large Friesian—an amount easily sufficient to cover the requirements for both maintenance and high milk production. This quantity of dry matter is, of course, very much larger than that usually advocated, but it coincides with the capacity of high-yielding animals of the larger breeds as judged by the experience of most practical breeders.

The second conclusion is that, in view of the considerable variations found in the rumen capacity of individuals within the same breed, and even of animals of identical live weight, *any* such standard as that suggested above must be subject to modification to meet the needs of the individual animal; that is to say, the breeder must be prepared to adjust the dry matter content of his rations to suit the particular needs of his stock. In this connexion it cannot be too strongly emphasized that an innate capacity for high milk production is not necessarily paralleled by a capacious digestive tract, nor does an animal which is endowed with a large rumen necessarily possess a marked ability to convert food constituents into milk. If maximum milk yields are to be obtained, it is obviously necessary to adhere to scientifically-determined feeding standards so far as the total intake of energy and protein is concerned: otherwise an animal will require to make good the deficiency in nutrients either by robbing its own tissues or by reducing the output of milk. Where, however, the breeder may and should exercise his own judgment is in selecting the constituents of his various rations (as well as in deciding on the frequency and order of feeding) *in such a way as to provide the required nutrients in a quantity of dry matter best suited to the needs of each individual animal* (and, incidentally, so

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as to provide an adequate quantity of coarse roughage) *without overloading the capacity of the animal and thus putting it off its feed*. It is here, perhaps, more than in any other branch of feeding practice, that the judicious selection of rations can ensure maximum milk production with minimum food wastage.

Bulk in Relation to Feeding. The practice of stating the capacity of an animal for food in terms of dry matter requires, however, further clarification, for the ability to consume a given ration will depend on two further factors, namely the actual bulk occupied by the foodstuff in the stomach, and the rate at which this foodstuff can be passed along the digestive tract.

It is well known that in their dry state foodstuffs vary in density; that, for instance, a given weight of bran or ground oats occupies a greater volume than the same weight of a concentrate such as earlnut or cottonseed meal. It is not so generally recognized that differences of a similar nature are found in the bulk occupied by various foodstuffs after ingestion, as a result of the moistening received from ingested water and from the copious flow of saliva into the stomach. That such differences exist was demonstrated some twelve years ago by Proctor and Wright, who arrived at their conclusions by studying *in vitro* the extent of swelling of different foods by artificial moistening. The results of their experiments were striking, for they were able to show that whereas some concentrates, such as earlnut cake and fish meal, occupied a relatively small bulk under these conditions, others, such as coconut cake and linseed cake, showed a remarkable degree of swelling, occupying a volume very much greater than many so-called "light" foods, such as bran or brewers' grains. Determinations of the moisture content of these concentrates after soaking showed, in fact, that they had absorbed water to the extent of over 88 per cent., that is to say, they contained as high a moisture content and occupied as great a bulk in the stomach as the dry matter content of succulent foods such as roots.

As far as ruminants are concerned, *the chief conclusion to be drawn from these experiments is that they dispose of the objections frequently raised against the feeding of roots to milking stock*. If roots were to be detrimental on account of their alleged bulk, so also would the high-swelling con-

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centrates. The question whether or not roots should be fed to such stock appears, in fact, to be primarily an economic one; in areas where roots are cheap or where they are necessarily included in the normal crop rotation there is no more objection to feeding them than there is to feeding linseed or coconut cake. *As regards non-ruminants, however, the abnormal swelling capacity of certain foods might conceivably act as a limiting factor to the food intake*, for the non-ruminant stomach is far less capacious than that of the ruminant, and is, therefore, less capable of dealing with bulky foods. Proctor and Wright found, in fact, some indication that with growing pigs the type of food included in the ration might affect the total food intake, and that with high swelling foods the animals tended to consume less. Unfortunately, this work has not been followed up, and the conclusions must meantime be accepted with reserve. The experiments do, however, appear to open up a new field which demands the attention of both nutrition experts and practical breeders.

Rate of Passage of Food. The second factor which will affect the capacity of an animal for food is the rate at which the foodstuff can be passed along the digestive tract. It has long been recognized that certain foods (for instance, cotton-seed products, bean meal and maize) are definitely binding, while others (for example, bran, molasses foods and linseed cake) are definitely laxative. Although practical breeders usually make allowance for these differences in planning their rations, it is only recently that definite evidence has been forthcoming that the mechanical effect of a food may exert a marked influence not only on the general condition of the animal but also on the actual liveweight gains. Probably the most notable contribution to this subject is that made by Sheehy, working at University College, Dublin. Sheehy used pigs as his experimental subjects, and examined the effect of feeding rations containing equal quantities of nutrients but varying in mechanical condition and laxative properties. He was able to show that the condition of the animals in the various experimental groups and the rate at which they increased in live weight could be related to changes in the character of the excreta, and that such changes depended in turn on the components of the ration. Rations containing linseed meal, bran, green foods, carrageen moss, etc., resulted in the voiding of more bulky and softer faeces and in better

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health and increased live weight gains, than those containing more costive foods.

It is clear from Sheehy's experiments, as well as from those of other workers in this field, that various factors may be responsible for the observed differences in the laxativeness and mechanical properties of different foodstuffs. With bran and carrageen moss the effect is assumed to be largely associated with the fibre content, with linseed meal it is probably due to the mucilaginous constituents, with green foods and roots the high moisture content and physical nature of the food are probably responsible, while with medicinal laxatives (e.g., paraffin oil or molasses) the effect is probably associated either with a direct lubricating action or with the presence of certain specific chemical constituents. Moreover, there may be differences in the function of various foods according to whether these are fed to ruminants or non-ruminants. For instance, it has been shown by numerous workers that with ruminants a definite quantity of bulky roughage is essential to enable rumination to take place; unless such roughage is fed a condition of partial fore-stomach stasis is produced which will lead to incomplete digestion of the food. On the other hand non-ruminants are unable to make full use of such roughage owing to the fact that they have no digestive mechanism comparable to the bacterial action which takes place in the rumen. These latter differences are, of course, recognized and allowed for in all modern feeding standards. The above discussion indicates, however, that, *in interpreting any dry matter standards which are laid down for the guidance of stock breeders, the significance of the physical and mechanical nature of the ration must in future be given even greater emphasis.* As Sheehy states in his paper, "A fuller recognition of the importance of the mechanical aspect of nutrition would help to harmonize the outlook and views of the scientist with those of the practical feeder on matters of the every-day nutrition of farm stock."

THE PROBLEM OF REDUCING MILK PRODUCTION COSTS

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When the Agricultural Economics Department of Bristol University issued the first of a series of returns on Milk Costings in 1934, I found that my code number was far too low on the list, and I realized that I must make a big effort to reduce my costs. This has not proved an easy matter, and I have come up against so many problems that they may be of interest to my fellow milk producers.

First of all, I must explain that I am farming a hilly farm in Somerset, somewhat scattered, though well served by public roads. When I started milk production, rather more than one-third of the area was arable, and I kept a breeding flock of Hampshire Downs, but, as I progressed and began grading my Shorthorns with a view to getting them all in the herd book, I realized that the farm would not carry the necessary complement of young stock in addition to the flock, so I reluctantly disposed of the flock, and reduced the arable acreage. To-day, the chief function of the arable land is to produce green fodder for the cows, with intervening straw crops.

A large part of the land is stone brash, and very shallow, so I feel it is absolutely necessary to have some crops on the arable to guard against a drought and shortage of grass in the summer, and in a long winter when hay may be short. Consequently, I grow a patch of maize and a succession of cabbage, kale and roots.

In changing over from mixed stock to dairy farming, I was faced with the problem of buildings, and owing to the scattered nature of the farm, I realized that one set of buildings would not serve the whole of the farm, so I decided to instal a Hosier Bail. I did not expect to obtain big milk yields at first; in fact, I wondered what effect the exposed nature of the farm would have on my milk yields. For that reason, I decided that it would be best to have a limited number of winter calvers at first, for, although the altitude is not great (about 500 ft. above sea level), the farm gets the full force

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of westerly gales from the Bristol Channel on the one hand, and the east winds from the Wiltshire Downs on the other.

To return to the costings issued by the Agricultural Economics Department of Bristol University, I found myself in the winter period, 1934-35, nearly at the bottom of the table, with a cost per gallon far in excess of the net return for my milk, but I was encouraged by the return which followed, that for the summer period of 1935, which showed my code number nearer the other end of the table. Obviously it is not possible to gauge correctly the cost of milk production in two periods of six months. No two people would agree as to the correct allocation of the costs when a cow was dry, or giving a small quantity of milk, and my returns had suffered on the one hand from the small quantity of milk produced during the winter period, while they looked unduly rosy in the second return, owing to the comparatively large production, when there was a good supply of grass. Consequently, one must look to the tabulated returns for the whole year in order to get anything like a true picture.

This return for the whole year showed that I had a cost of production above the average, and I had now to consider whether it would pay me to increase my winter production. As all farmers will realize, I was then confronted with many problems. To what extent would the milk yield be affected by the fact that the cows would be exposed to the elements all the time? What would be the cost of the additional foodstuffs required to maintain the animal heat under these conditions? To what extent would the summer yield be affected, and by how much would the summer costs be increased?

Milk Records assisted me at this stage. I found that some of the autumn-calved cows, even under my difficult conditions, had quite as good yields as the spring calvers, and we all know that a good autumn calver will increase her yield when the grass comes in the spring, however scientifically she has been rationed before. I therefore decided that I would increase the number of autumn calvers, but not too rapidly, for, under my system, there is another very serious problem. To feed a dozen cows with hay in a field is quite a different matter from feeding forty. With the larger number of cows moving from one heap of hay to another, there is bound to be considerable waste in bad weather. Good hay will be trodden into the ground instead of being eaten by the cows.

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One realizes from the costings returns that hay is one of the chief costs in the winter, and I was anxious to reduce mine. I am convinced that too much hay is often fed, and, if there is careful rationing of concentrates according to yield, hay costs can often be reduced without a reduction of yield.

With the hay problem before me, I decided to go cautiously with regard to the number of cows in full milk during the winter period, but I did increase them, and I had the satisfaction of seeing that my total costs were reduced by 0.26d. per gallon during the following twelve months. This is, of course, a small reduction and may be accounted for in many other ways. Before we can get definite results, costings will have to be kept for many years, and the results compared on many farms. As a matter of fact, my yield per cow in the second year of the costings was higher than that of the first, a factor which, generally speaking, would reduce the cost of production, but this requires qualification. There is a great divergence of opinion as to which is the most profitable cow to keep, the moderate yielder of say 800 gallons per year, or the cow with a high yield. Some practical men would even maintain that the 600-galloner fed on the produce of the farm with little artificial feeding is more profitable than either. It is certainly true to say that if a high yield is followed by sterility, as so often seems to happen, then the moderate yielder which produces a good calf each year must be the more profitable proposition.

Obviously, it is not as easy to give individual attention to each cow on a milking bail, as it is when the cows are milked by hand in the stall. Feeding is extremely important, as we all know, and with the hope that feeding bills would be kept under control, at the same time that milk yields are encouraged, I have always paid a bonus to my cowman and his assistant. Even so, one finds great variation in yields from one cow to another, and even in some instances from the same cow in different lactations. We all know that it is the cow that keeps up a steady flow of milk over a long lactation period which is the most profitable. I am convinced, too, that temperament plays a big part in milk production. For example, a good cow may not take kindly to a milking machine, or a cow may not give her milk as freely to one milker as she will to another. For these and other reasons, I decided to keep a self-contained herd, having in view a herd created from the best cows only. How simple it sounds. One

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is told, "Buy a good bull, he is half the herd," and one buys a good bull, well proportioned, with a long pedigree and milk on both sides. How disappointing it is to find that many of the offspring are not as good as one had hoped they would be. Like does not always beget like; there are sure to be failures, but with careful selection, I am still hopeful of increasing my herd average and so reducing my costs per gallon.

Other factors which loom large in the picture are milking costs, concentrates fed before calving, and the costs of other home-grown feeds.

The first point, milking costs, is an interesting one, and I was not surprised to hear from an Oxford economist that they had found that machine milking was costing on an average $\frac{1}{2}$ d. per gallon more than hand milking. I suggest that there are two main reasons for this. The first is that, generally speaking, hand milking is practised in the smaller herds, where the owner is usually one of the milkers, and where more individual attention is given to the cows, with the result that the herd average is higher and the bill for concentrates often lower. The second is, of course, the cost of running the machine. A farmer to-day must be an engineer as well as a farmer, for unless careful attention is given to the machine there will soon be large repair bills, and costs will rise accordingly.

As to the second point—concentrates fed before calving—I do not think there is the slightest doubt that it pays to feed before calving, but there is still the further question how much and for how long, and here there will be a considerable difference of opinion amongst farmers. It is impossible to treat all cattle alike, but the main consideration is to get the animal in as fit a condition as possible before calving. With this end in view, I should begin feeding at least three weeks before the calving, and increase the amount of concentrates as the date draws near.

With regard to home-grown foodstuffs, I often wonder if these crops are profitable. I have studied the Bristol returns many times, picking out the producers who grow catch crops and haul them out to the cows. I find that their costs per gallon vary tremendously, they figure from one end of the table to the other. That these crops are costly to produce there is no doubt. The costs begin with the preparation of the ground where they are to be sown; and from the time they are drilled to the time they are cut and hauled to the field for

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consumption the cost is cumulative; but, that they are invaluable in time of drought or when hay is short, is beyond question, in addition to the fact that they are a valuable aid in maintaining the health of the cows.

It is unnecessary for me to stress the health of the cows as a factor in milk production costs. I believe the average life of the dairy cow in the herd is approximately three years. Now it does not seem unreasonable to suggest that this might be doubled, and what a saving would result if this could be accomplished. If we could breed all healthy cows and all good milkers, the number of young stock required to fill up the herd would be halved and a larger dairy herd could be kept on the same acreage.

This was one of the reasons why I decided to embark on T.T. Milk Production. I am hopeful that, by eliminating tuberculosis, I may get a healthier herd with a longer life in the dairy, but the process of elimination is an expensive one, and as a consequence, my production costs increased at this stage. I do not think myself alone in finding that some of my best cows reacted to the test. In fact, in my original test the average yield of the reacting cows was very considerably above that of the rest of the herd. I have, however, continued on my way and am now looking forward to seeing my name added to the attested roll, when that extra penny per gallon to which I shall be entitled will be very useful in helping to defray the costs involved.

I must just mention abortion and sterility. Unfortunately, both are very prevalent in this part of the country, and I have unfortunately been visited by both these diseases. Notwithstanding all our efforts to prevent the spreading of infection, I have had several cases of abortion, but what has been worse, I have not been able to get my cows in calf. The trouble started at the end of 1937, and as a result I had no calf born on the farm from July, 1938, until January of this year. What this will add to my milk production costs I cannot say, but, unfortunately, I do know the difference between this winter's milk cheques and those of the winter of 1937-38.

I should like to conclude this article by suggesting that much more attention should be devoted to research with regard to these diseases. Have we introduced them by artificial feeding and our quest for higher milk yields? These points undoubtedly emphasize the need for active research.

NITROGEN IN SPRING MANURING

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Late Spring Applications. A wet winter is generally believed to result in considerable loss of nitrate nitrogen from the soil, so that crops may suffer from a shortage of available nitrogen in the succeeding spring. R. A. Fisher in a paper on the influence of rainfall on the yield of wheat at Rothamsted (*Philos. Trans. B.* 213, 89-142) showed the apparently "predominant influence of the effect of rain in removing soil nitrates," and results of recent experiments at Cambridge have borne out the value of nitrogenous top-dressings to wheat, especially on poor heavy land, after a wet winter (Garner, F. H., and Sanders, H. G. *Journal of Agricultural Science*, April, 1936).

In most parts of the country, December, 1938, and January, 1939, were extremely wet months and, though February by its low rainfall and relatively mild conditions probably helped to counteract the earlier losses in many districts, there can be no doubt that autumn-sown wheat should receive a top-dressing of nitrogenous fertilizer on all but rich soils and land in really good heart, especially if March or April prove to be wet and somewhat unfavourable to crop growth. Where growth is very strong and the crop shows a deep green colour, top-dressing should not be necessary, but elsewhere there is probably ample justification for a top-dressing in May. Even after a bare fallow and other similar circumstances in which nitrogenous top-dressings are often held to be unnecessary, the question of a top-dressing should be seriously considered in relation to the present condition of the crop. For instance, on Broadbalk Field at Rothamsted, a bare fallow on plots cropped continuously with wheat and receiving no nitrogenous fertilizer usually gives a substantial increase in the yield of wheat in the succeeding year, but not in subsequent years. This increase is held to be largely due to the nitrogen accumulated by the bare fallow and, during the period 1932-35, in the year following a bare fallow the yield from plots receiving no nitrogenous fertilizer was almost as good as the yield on plots receiving 3.7 cwt. of sulphate of ammonia

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per acre. In 1936, however, the wheat crop growing on plots bare fallowed in 1935 was very little better than the crop on plots not bare fallowed in the previous year, presumably due to the washing out of accumulated nitrogen by the high rainfall, especially during the wet winter of 1935-36.

MEAN YIELD OF WHEAT GRAIN (CWT. PER ACRE)				
	<i>One Year after Bare Fallow</i>	<i>Two Years after Bare Fallow</i>	<i>Rainfall (inches)</i>	
			<i>Oct.-Mar.</i>	<i>April-Sept</i>
Mean of 4				
years 1932-35..	16.3	6.7	11.6	12.1
1936	7.8	6.4	19.6	17.1

There is still plenty of time to get the full benefit from a top-dressing for wheat since, from most recent experiments, late April or May seems quite early enough to apply the nitrogen, and this late application actually involves less risk of inducing lodging.

As far as spring-sown corn is concerned, the nitrogen, like the phosphate and potash, is certainly best applied to the seed-bed, or very soon after seeding, but in some instances it is still not too late to try to remedy any serious deficiency of nitrogen, especially where a crop is showing marked signs of nitrogen starvation. For instance, spring wheat, except where it looks really strong and of a good colour, should be top-dressed in May in the same way as winter wheat. Again, winter-sown barley usually requires a nitrogenous top-dressing in the spring, whilst in experiments described by Hunter (*Journal of Agricultural Science*, July, 1938) nitrogen applied to spring-sown barley up to the time at which the tillers began to assume a vertical position (usually 7-9 weeks after seeding) increased the yield without spoiling the quality of the grain, even for malting purposes. Hunter's results, using the variety Spratt Archer and nitrate of soda at the rate of 1 cwt. per acre, showed that "the effect of nitrogen on yield and quality of grain depends upon time in relation to the stage of plant development at which it was applied; the early applications (up to tillers becoming vertical) enhanced the yield without detriment to the quality of the grain whilst the later applications (time of flowering and after) did not increase the yield but increased the total nitrogen content and consequently reduced the malting quality of the grain."

There is, of course, always the risk of lodging to be considered, and seedbed application is no doubt safer and better

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as a general rule, but where a cereal crop is showing obvious signs of insufficient nitrogen supplies it is apparently even now not too late to consider a top-dressing of nitrate nitrogen in many districts.

The importance of nitrogen for potatoes and sugar beet has been emphasized in recent issues of this JOURNAL, and though it may be too late now to alter the manuring for this season's potato crop or even the main fertilizer mixture for sugar-beet, it is still possible to make up for any shortage of nitrogen in the sugar-beet manure by top dressing the beet at singling time with 1-2 cwt. per acre of a quick-acting nitrogenous fertilizer such as nitrate of soda or nitrochalk. The application of a part of the nitrogenous fertilizer for sugar-beet as a top-dressing at singling time was formerly regarded as better than applying the whole dressing at seeding time, and though experiments have failed to show any definite superiority from dividing the nitrogen into two applications in this way, there is ample evidence to justify an additional application as a top-dressing where the seedbed application was only small.

Mangolds, swedes, kale and other root crops can also be top-dressed with nitrogenous fertilizer in the same way as sugar-beet if there is reason to think that the seedbed dressing was not large enough.

Loss of Nitrogen from Farmyard Manure. The response to artificial nitrogenous fertilizer by crops receiving farmyard manure is, of course, partly dependent on the "quality" of the manure and the way in which it is handled. By taking a little trouble to reduce unnecessary losses of plant food, particularly nitrogen, from the dung it may be possible to reduce the amount of artificial fertilizer required, though admittedly, even if all the soluble plant food is lost, the land itself will still benefit physically from the humus supplied by the dung. The biggest losses during the making of manure usually arise from failure to conserve the urine, or from the effects of too much air or too much water in the manure heap, e.g., a badly made heap, too loose or made in such a way that rain runs into it and drains away from the bottom, carrying soluble plant food with it. But almost equally serious are the losses that occur during the actual application of the manure to the land, especially if it is left lying about on the surface before being ploughed or covered in.

In America and on the Continent extensive experiments have

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been made on the possibility of reducing the loss of nitrogen from farmyard manure. A report from the Vermont Agricultural Experiment Station, published in 1937, discusses the various problems involved and describes laboratory experiments on methods of controlling the losses. It is admittedly not possible to reproduce exactly in the laboratory the varying conditions that may exist in a heap of manure, or during the handling and spreading of the material on the field, and hence there is need for a good deal of caution when considering the results of experiments made in a laboratory. Nevertheless, it is possible to form a fair idea of the probable losses, and more particularly the factors that give rise to them, from such small-scale experiments. Of the possible ways of preventing loss of nitrogen during making, that involving the addition of some chemical to form stable salts with ammonia received most attention, superphosphate in particular being used in several trials. The Vermont experimenters do not accept the view that gypsum alone is satisfactory, but suggest that the presence of mono-calcium phosphate in addition to gypsum (superphosphate consisting mainly of calcium sulphate or gypsum and mono-calcium phosphate) gives a mixture which is far more efficient than either of its constituents.

For maximum efficiency the superphosphate must be intimately mixed with the manure, especially the urine, at the earliest opportunity, the most satisfactory method being to spread it in the gutters and on the floor of the cowshed. Further, though 100 lb. of superphosphate per ton of manure should theoretically suffice to prevent serious loss of nitrogen, in practice considerable loss may occur even when 300 lb. per ton is used. Hence, though the superphosphate eventually finds its way on to the land, the amount required per ton of manure is a serious consideration. The large amount of material required has also been emphasized by Lemmerman, who, in summarizing the results of many German experiments on farmyard manure, concluded that no conserving material such as gypsum or superphosphate was of practical value since the quantities required are too large to be economical.

But the Vermont experiments serve also to emphasize other directions in which much nitrogen is, or may be, lost, and methods for reducing such loss. When manure is spread on the surface of the land and left for some time before ploughing in, it may dry out completely, especially in dry, windy weather. In the course of this drying, a very large part of its available

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nitrogen may be lost into the air by volatilization as ammonia. Hence it is of the greatest benefit to get the manure ploughed in as soon as possible, for even the small heaps in which it is usually set out in the field are too small to prevent loss by drying-out in a drying wind, and once the manure has been spread on the surface of the ground the loss is extremely rapid in the absence of rain. The losses that may occur during spreading are well illustrated by the following figures obtained in experiments in Germany quoted by S. E. Scammell (this JOURNAL, March, 1936).

<i>Treatment</i>	<i>Yield of Swedes (referred to that where full dose of dung was ploughed in at once as 100)</i>
Full dose dung ploughed in immediately after spreading	100
Full dose dung ploughed in 1 day after spreading	94
Full dose dung ploughed in 4 days after spreading	86
Half-dose dung ploughed in immediately after spreading	88
No dung	76

In other words, the complete omission of dung reduced the crop by 24 per cent., whilst leaving the dung on the surface of the land for 4 days before ploughing in reduced the crop by 12 per cent., giving a yield no better than the half dressing of dung ploughed in immediately after spreading. Hence half the value of the dung to the first crop was lost by leaving it on the land for 4 days before ploughing in. Of course, the extent of the loss must vary considerably with weather conditions—rainy weather tending to wash the available nitrogen into the soil, thereby preventing the loss of ammonia into the atmosphere.

On grass land where it is not possible to bury the manure the only means of getting the full benefit of the readily available nitrogenous constituents is by action of rain washing the soluble compounds into the soil before they can be volatilized. For this reason late applications of farmyard manure to grass land are likely to prove more wasteful of nitrogen than early applications, especially if a spell of warm dry weather sets in.

It is also interesting to note that, in the Vermont experiments, losses were found to occur from exposing manure to the action of frost. These were less serious than those that occurred through drying, but up to 50 per cent. of the available nitrogen was lost by manure kept at 23°F. for a period of 48 hours, a result comparable with that of Continental workers who have

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reported a loss of one-third of the ammoniacal nitrogen when manure was spread on snow.

The better the manure the greater may be the loss of nitrogen from these various causes, for manure from cake-fed cattle contains most of its extra nitrogen in the readily available form, i.e., the form that will suffer most by mishandling, as is shown by the fact that, though dung made by cake-fed cattle may be more effective than that from cattle on a store ration in the year in which it is applied, there is usually little difference between the two types in subsequent years.

Farms employing the minimum amount of labour, as many are doing to-day, have to concentrate on doing the various jobs when most convenient to the remainder of the farm work rather than at the time when they really can be done to the best advantage. Again, it is, of course, relatively easy to make up for a loss of plant food by an increased dose of artificial fertilizer. But, even so, it seems worth while to keep the losses as low as possible. To do this, three of the most important points are to conserve the urine by the use of plenty of litter or a properly constructed liquid manure tank, to protect the manure from loss during storage by making a compact heap, and finally, get the manure into the soil as soon as possible after it has been carted on to the land, otherwise the care taken in its making and storage will have been largely wasted.

AN OUTLINE OF AMERICAN AGRICULTURE

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When considering the American agricultural enterprise, it may be helpful to bear in mind that in America 939 million acres are classed as farmland, a fact that must be given considerable weight when comparisons are made with British agricultural conditions. Further, the climate in the United States varies from subtropical to that of the northern Temperate Zone, with farming of some sort carried on at elevations ranging from virtual sea level to 5,000 ft. or more.

Under such wide variations in soil types, accompanied by such diverse climatic conditions, the American agricultural enterprise has naturally taken many forms. Specialization has frequently been a matter of fundamental geography rather than of conscious choice on the part of the farmer; his selection of products has been dictated to a considerable extent by the natural conditions existing in his particular region.

The Agricultural Regions. From the very beginning of colonial expansion on this continent, our agriculture has assumed a regional pattern. In the south, tobacco, cotton, and rice soon developed into the leading crops. North of Virginia, grains and live stock dominated the colonial farm enterprise. The later westward migrations carried with them many of the regional agricultural characteristics that had been established in the colonial period.

American farmers in a number of important regions conduct their operations along lines regarded as representing a well-balanced agricultural programme. This is particularly true in those regions where grain, live stock, and dairy products are all present in the farm enterprise. But some farmers, particularly in the south, have placed so much emphasis upon growing the specialized crop in order to secure a cash income that they have become actually deficient in supplies of subsistence products. This is because cotton culture, generally speaking, brings a relatively higher cash return than does the production of any other crop that might be grown com-

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mercially in the cotton country. A somewhat similar situation has developed in certain western regions where wheat production is out of proportion with respect to other crops, but where wheat represents the greatest cash return. This tendency in both regions has turned out to be dangerous in periods of low prices for the main crops. This is especially true with small operators. During recent years, both Federal and State authorities have made serious efforts to stimulate the production of food and feed in the specialized cash-crop regions.

In view of this development of regional specialization in America, perhaps it is not surprising if we have formed the habit of thinking of our agricultural regions in terms of the chief products. The terms "Cotton Belt" and "Tobacco Belt," for example, suggests more or less definite sections of the country where cotton or tobacco are the leading crops. Naturally, the designation of those regions represents a certain degree of arbitrary allocation, and there is some very considerable overlapping. A fair idea of the national agricultural pattern may be gained, however, from an outline of the chief producing regions.

THE COTTON BELT. This has been so closely associated with British industry for so many years that in all probability it is the best-known American agricultural region. It includes about 36 million acres planted to cotton, located chiefly in the States of South Carolina, Georgia, Alabama, Mississippi, Louisiana, Arkansas, Oklahoma, and Texas. The crop, as a whole, averages about 12 million bales annually. The main belt is practically unbroken for a distance of about 2,000 miles from eastern North Carolina to the western border of Texas. About one-third of the crop is now produced in the latter State, where large areas of relatively level land under good weather conditions can produce cotton at costs lower than those that prevail in the older, rolling lands of the eastern States.

Temperature and rainfall are the chief natural factors limiting the extent of the Cotton Belt. The variety of soils now producing cotton suggests that, if the enterprise there would be profitable, the belt could be extended considerably. Fundamentally, cotton requires about 200 days of warm weather and about 20-23 in. of rainfall where irrigation is not used. Too much rainfall encourages damage from boll weevil, which has driven cotton away from tidewater on the

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Atlantic Coast, and contributed to the virtual elimination of the once-flourishing Sea Island cotton industry.

According to a survey made in 1935, and using data for 1930, there were at that time 1,827,000 farms in the Cotton Belt, with an average size of about 85 acres. On each farm an average of about 20 acres was planted to cotton. These figures cover all operations ranging from the traditional "40 acres and a mule" to farms averaging about 250 acres, of which about 60 acres are in cotton. Some operations include as many as 1,700 acres of cotton under one management. The cotton farms have a population of close to 10 million people and represent the economic basis of a population many times larger.

Social aspects of cotton production are a source of serious concern. The whole problem has been the object of intensive study in our efforts to find a way of raising the income of a group of producers who are largely tenants, and whose outlet for their main crop appears to be seriously threatened. Production has been geared to an export market that takes from one-third to one-half of the crop when the world's industrial wheels are turning freely. There is little wonder that the southern farmers watch carefully for signs of greater industrial activity at home and abroad.

THE TOBACCO BELT. For more than 300 years, tobacco has been grown in our southern States, much of it being used in Great Britain. To-day, the tobacco-growing industry is so specialized that it is scarcely possible to think of the crop except in terms of type. All told, however, about 3 million people are engaged in producing over 1,000 million pounds of tobacco annually on an area of about 1.5 million acres. Cultivation is intensive, and soil conditions are highly important. About half a million farms produce some tobacco, the average acreage per farm being about 3 for tobacco and 80 for all crops.

The leading tobacco area produces about 600 million pounds annually of flue-cured tobacco. It lies chiefly in North Carolina, which has gone ahead of Virginia in this respect. This is the type of tobacco that is commonly used as the basis for most cigarette mixtures in this country and in Great Britain. About 60 per cent. of the flue-cured crop is exported, largely to Great Britain and the Orient. Burley, the second most important cigarette tobacco, is produced chiefly in Kentucky and Tennessee. Another tobacco area, in southern

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Maryland, produces a type that has been used in recent years for cigarette blends. Again, the Tennessee-Kentucky area is noted for certain dark-fired types utilized chiefly in pipe and chewing mixtures.

Cigar-type areas are as widely scattered as Florida and southern Wisconsin, western Ohio, and central Minnesota. The products of these sections are used chiefly as filler in the domestic cigar industry, although some is suitable for use as binder and wrapper leaf. Probably the most specialized undertaking affecting tobacco production is the growing, under shade, of cigar-wrapper leaf in Connecticut and in the Georgia-Florida area, which competes with the wrapper leaf imported from Java and Sumatra.

THE WHEAT BELT. Wheat is produced in most parts of the United States. It frequently forms an important part of mixed or general farming practice. Wheat has a much wider climatic range than either corn or cotton, and is the crop that is best adapted to some of our relatively dry western regions where the range of rainfall is between 20 and 30 in. The American wheat crop of from 700 to 900 million bushels is grown on about 62 million acres (speaking in averages). Domestic requirements account for about 650 million bushels.

Of the nation-wide acreage, about 38 million acres lie in the three regions where the crop is distinctly a major enterprise. The largest of these is the Hard Winter Wheat region, which accounts for more than 19 million acres, and centres in the State of Kansas. Parts of Oklahoma, Texas, New Mexico, Colorado, and Nebraska are important in this region. It was in this territory that the droughts and dust storms of recent years were particularly severe.

The Hard Spring Wheat area, accounting for about 15 million acres, lies chiefly in north Dakota and is adjacent to the southern edge of the wheat regions of Canada. Included in the American Hard Spring Wheat areas are parts of South Dakota, Montana, and western Minnesota.

The third region, producing white wheat, comprises parts of northern Oregon and eastern Washington and western Idaho. These three States together account for about 3 million acres of a soft white wheat similar to that which is produced in Australia.

The broad, level, expansive plains country is ideally fitted for wheat culture and the use of machine methods. Under normal production conditions, the plains country has the

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lowest production costs per bushel of any part of the United States. The units of operation are large: the acreage in wheat per farm averages about 200 acres for Hard Spring wheat and around 300 acres for Hard Winter wheat. Some operators farm more than 5,000 acres each.

The future of wheat constitutes one of the outstanding American farm problems. Domestic consumption shows no signs of being able to absorb any appreciable additional share of the output of an American agricultural industry geared to supply a substantial export market. Average domestic requirements of around 650 million bushels apparently can be supplied by about 50 million acres at average yields. As things are now, exports of American wheat can scarcely be depended upon to take the product of 6 million acres; in fact, exports of recent years of normal production have been considerably below that level.

What to do with the output of from 8 to 10 million acres of wheat land constitutes the heart of the American wheat problem. Most of those acres are identified with the Hard Winter wheat of the south-west. They produce considerably more than enough to meet this country's requirements for that type of wheat. The United States also produces more Soft Winter wheat than is needed, but the areas producing that crop can be more easily shifted into other crops than can the semi-arid Hard Winter wheat areas.

THE CORN BELT. Corn (maize) is sometimes regarded as the foundation of American agriculture. Certainly this is true in connexion with livestock farming. Corn is grown in every State, but commercial production for grain is found chiefly in those States that have relatively warm temperatures and a fair degree of moisture. It takes about 120 days without frost to plant, grow, and mature a corn crop. The crop, as a whole, occupies about 98 million acres, with an average output of about 2,500 million bushels. Of that amount, about 90 per cent. is fed to live stock.

The Corn Belt proper accounts for over 42 million acres, stretching across the central section of the United States from central Ohio to central Nebraska and eastern South Dakota. This belt also covers about half of Missouri, parts of eastern and northern Kansas, and southern Minnesota, and a small part of south-western Wisconsin.

This whole region as outlined is the heart of the surplus food production area of the United States. In addition to pro-

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ducing more than half of the corn crop, the States identified with the Corn Belt account for 17 per cent. of the wheat, 61 per cent. of the oats, and 10 per cent. of the vegetables produced for sale. In addition, usually about 44 per cent. of the cattle, 65 per cent. of the hogs, 47 per cent. of the chickens, and 21 per cent. of the sheep estimated annually as being on farms in the United States are found on Corn Belt farms. Corn is our chief feed grain; in years of normal production, corn accounts for about 75 per cent. of the weight of all feed grains.

More than 4 million people operate in the Corn Belt, in agricultural enterprises. Their farms, averaging about 165 acres in size, are operated chiefly to produce live stock for sale. This involves the breeding and fattening of beef cattle and hogs, and the fattening of cattle purchased from regions outside the Corn Belt. Dairying is an important feature of Corn Belt farming, especially in sections fairly close to urban centres.

The Corn Belt has been important in the growth of such leading American cities as Chicago, St. Louis, and Kansas City. These, and numerous smaller communities, are the chief processing centres for products from the Corn Belt. In each of these cities, especially in Chicago, the slaughter and processing of live stock is a major industry. This development has resulted in a higher degree of centralization of meat processing and distribution than occurs in most countries. In this way, products of the Corn Belt are prepared for marketing in communities hundreds of miles distant, and for export. Lard is an especially important item for export, and Great Britain for many years has been our leading foreign market for lard.

LIVE STOCK. The production of hogs is so closely identified with the Corn Belt that the observations made on that region may properly be allowed to stand for hogs as well. But it might be added that hogs are found on nearly every American rural holding, the total numbers on farms for the country averaging around 55 million in January of each year. The average annual federally-inspected slaughter of hogs amounts to about 45 million head. In addition, there is a large local and farm slaughter.

In the western one-third of the country there are still large areas in which the raising of cattle and sheep is regarded as the leading agricultural enterprise. This region represents, in general, all of the agricultural land west of the wheat,

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cotton, and corn regions and east of the Pacific Coast States, but it includes parts of California. This vast area is known as the Range Livestock region, and constitutes our primary source of lamb and mutton and wool. It is also important in the production of beef cattle. This western country is given over to grazing because the rainfall is too light to support other forms of agriculture on an economic basis.

The Range Livestock region is all that is left of a once vast area devoted to grazing. Even now, however, the area in farms and ranches is placed at more than 178 million acres, only a small part of which is in crops. Farm holdings average close to 1,000 acres each; some of them exceed 50,000 acres. In addition to the private holdings, live stock may be grazed on the public domain under certain conditions. The whole region has an annual cattle population ranging from 8 to 10 million head. A large percentage of the cattle marketed out of the Range country are sold to farmers in the Corn Belt for fattening. For a number of years, the United States has been on a net deficit basis with respect to beef cattle. The national total on farms stands at about 65 million head.

The Range country accounts for about half of the sheep on farms in the United States. With total sheep numbers at about 53 million head on farms annually, this country is about self-sufficient as to mutton and lamb, but normally is deficient in wool. When industrial activity is good, it is necessary to import at least one-third of the wool required by our factories. The market for mutton and lamb is the chief factor that limits sheep production in the United States. Our *per capita* consumption is substantially below that of the United Kingdom and shows no tendency to increase. Were the situation otherwise, the United States would meet a much larger share of its own wool requirements than is now possible.

DAIRY PRODUCTS. Milk production is widespread throughout the United States, the total output exceeding 11 billion gallons annually. Of that amount, from 3 to 5 billion are produced in a region bordering Canada and stretching from western Minnesota to eastern Maine. Wisconsin, Minnesota, and New York are the States of greatest concentration with respect to milk production. The income of American farmers from dairy products is greater collectively than the income from any other farm enterprise.

By far the greater part of the milk produced in the Dairy Belt is sold as butter and cheese. Except in the winter season,

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the United States produces sufficient butter to meet its requirements, and to allow for a small export surplus. In regard to cheese, however, there is a year-round demand for imports, especially of European types the production of which has not been well developed in this country. Italy is the chief supplier of the imported cheeses. Relatively small amounts of cheese are received from Canada of a type similar to our own.

POULTRY. The keeping of poultry, especially chickens, is common to practically all American farms. Of chickens alone, we annually estimate our farm flocks as comprising about 380 million birds. The collective farm income from poultry is second only to that received for dairy products.

No one part of the country predominates in poultry production. The factors determining locations for commercial production are (1) climate, (2) feed supplies, and (3) proximity to a favourable market. Thus, there are farmers in all sections of the country who regard poultry and eggs as their chief cash products, but there is some tendency toward concentrated production in grain-growing areas.

OTHER FARMING ENTERPRISES. There are a number of smaller but well-recognized American regions of specialized production. For example, Florida is a leading source of fresh vegetables during the winter months, and is even better known as a producer of oranges and grapefruit. In California, there is an even greater production of citrus fruits, including lemons, and in the southern part of the State, irrigation has made possible an extensive production of out-of-season vegetables. A similar region is found in the Rio Grande Valley of Texas. In the north, certain eastern seaboard regions have specialized in vegetables. Even more important are the apples and pears of the Pacific north-west, and the California peaches and other soft fruits. In fact, fruit has developed in so many parts of the country that it would be easy to devote much space to describing those products only.

Trends in Farm Operations. In the light of the many broad divisions into which American agriculture falls, it is virtually impossible to make any valid generalizations about farming methods. The question of farm labour in the Cotton Belt, for example, is quite different from that prevailing in the Corn Belt or in the Livestock Range regions. The emphasis placed on the leading product in the various main regions outlined makes our procedure so different from that

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followed in Great Britain that to attempt comparisons is likely to be misleading.

Ordinarily, the American general farming enterprise is a family affair. In the south, the farmer and one grown son usually can manage 30 acres in cotton or 10 acres in tobacco and a fair amount of subsistence crops, with extra help at harvest time. In the Corn Belt, two men can handle from 120 to 150 acres for most of the year. In the wheat country, two men can manage up to 2,000 acres with good machinery and extra harvest hands. Much depends upon the extent of mechanization on the farm, but where the farm is not large enough to support such expensive machinery as a thresher, it is customary to engage the services of a custom thresher. Practically no small grain is harvested by hand in the United States. A considerable amount of corn is cut by hand and is a feature of good farm practice.

The Cotton Belt continues to require a relatively high amount of labour per acre the year round. Mechanization has made less progress in cotton than in most of our other major crops. A considerable part of the crop is produced by tenant farmers who work the lands of a large owner. The tenants and their families provide practically all the labour, the owner contributing supervision and supplies. The ramifications of the current labour situation in the Cotton Belt constitute an absorbing study in economics and sociology; its successful handling is linked with the efforts to solve a major American agricultural problem.

The outstanding single development in American farming during recent years has been the extension of mechanization. The petrol-driven tractor has displaced horses and mules to a very marked degree wherever the type of farming will permit such a change. In 1920, the number of horses and mules on farms was 25,742,000 head. In 1938, the number was down to 15,640,000 head. In grain growing, this development has reduced markedly the number of times a field must be worked to prepare it for seeding, for the tractor can haul several more tools than was usually possible with the ordinary two-horse farm team.

On many farms, practically all outdoor jobs that require power are performed with the help of the tractor, which furnishes either drawbar or belt power. Manufacturers have succeeded in designing tractors that are suitable for an increasing amount of work under conditions formerly regarded

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as impracticable for such machinery. Small stationary petrol engines of $\frac{1}{8}$ to $\frac{1}{2}$ horsepower also have an important position on American farms.

The depression period applied a check to mechanized operations in many American farming regions, chiefly because of the lack of cash for tractor fuel, oil, and repairs. For a few years, horses and mules again were the more economical sources of power, since their maintenance could be provided without a cash outlay. It is evident, however, that with reasonably good financial returns to farmers, tractor power will continue to strengthen its position in our farm operations.

Electrification is a newer development in American rural life. In many States there are large areas in which electric power reaches most farmhouses but, by and large, only a fair beginning has been made. Enough has been done, however, to reduce materially the load of manual labour, particularly in those household tasks that are usually performed by the farm women. The promotion of rural electrification is one phase of the national programme designed to improve the general agricultural situation.

In certain parts of the country, particularly the south and west, erosion control is assuming a more prominent position in our farm operating programmes. In the south, losses from water erosion have been a serious matter for a long period of years. In the west, particularly in the Hard Winter Wheat Belt, the land has not been under the plough for so long a period as have our cotton lands, but losses from wind erosion constitute an even more serious control problem. The national policy with respect to soil conservation contemplates an extensive programme of erosion control. The limitations of this brief article do not allow for adequate treatment of this highly important subject, but it may be said that the work of combating the losses from erosion is now getting under way on a national scale.

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EDITOR'S NOTE. Readers interested in the problems of American agriculture will find a full discussion of the subject in the recently-published Report of the U.S. Secretary of Agriculture, 1938. Space does not admit of a summary of Dr. Wallace's report, but copies may be obtained from the Superintendent of Documents, Washington, D.C., price 20 cents.

ERADICATION OF CORNFIELD WEEDS

H. C. LONG

During the present century many attempts have been made to discover satisfactory chemical means of destroying weeds in growing crops without injuring the crop itself. The only crops grown throughout the country that can be really satisfactorily treated, however, are the cereals. At the beginning of the century Charlock in corn crops could be destroyed by spraying with a solution of copper sulphate or iron sulphate; and later it was found that finely-powdered kainit or a solution of sulphate of ammonia was partially effective in destroying this weed. Kainit, however, at the rate required, might prove costly if the soil did not need potash, while sulphate of ammonia might, on the other hand, also serve as a stimulating top-dressing at about the right time—April to early June.

In recent years the older treatments have been very largely replaced in this country by two others: (1) Spraying with a solution of commercial sulphuric acid (Brown Oil of Vitriol, known in the trade as B.O.V.); and (2) dusting the crop with powdered cyanamide.

These two methods have proved highly successful in all parts of the country, though they are still much more widely appreciated and employed on the Continent: France alone uses sulphuric acid on some 500,000 acres annually; cyanamide is very extensively used in Holland, Germany and elsewhere.

During the next few weeks corn crops may be treated by one method or the other, and it may be regarded as certain that nine times out of ten—or more often—the crop will benefit greatly, being not only freed from weeds as compared with an untreated part of the field, but yielding more and better straw and 20-70 per cent. more grain. It should be remembered that the benefits may be quite substantial. A cleaner crop is more readily harvested, and the grain is more easily cleaned when threshed; the straw crop is larger and cleaner; the yield of grain is heavier; and as weeds are killed the soil is much less heavily contaminated with weed seeds. At any time, therefore, treatment by sulphuric acid or cyanamide should be attractive to farmers, if the cost is reasonable and provides a good investment. It may be worth while to examine the two methods separately.

Sulphuric Acid Spraying. This method may be employed



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by the farmer himself under his own supervision, or in co-operation with other neighbouring farmers; or it may be carried out under contract by local undertakings who will give a firm price per acre in accordance with the particular conditions—distance, access, etc. The difficulties in regard to spraying by the farmer himself are that good machines are costly; the machine needs to be well looked after if depreciation is not to be heavy; and the handling of sulphuric acid necessitates the use of a definite technique, or mishaps to clothing may occur, while a weak solution may not kill the weeds. Nevertheless, any farmer who has a considerable area to spray, say 200 acres, might save a good deal of money if he had a machine of his own. The technique is really quite simple, and it is only necessary to follow clear rules in mixing, and in keeping the machine clean and free from acid after use. After each day's work the machine should be washed through with clean water or, better still, by rinsing and running a little washing soda solution through it. This may well prolong the "life" of the machine from three or four seasons to seven or eight, so saving a lot of depreciation.

Co-operative use of a jointly-owned machine has been tried, but is not regarded as very satisfactory, if only because there is too apt to be a demand on the part of the co-operators for use of the machine at the same time.

Farmers who have only a few acres to spray will be well advised to contract for the work to be done.

Under the contract system the farmer undertakes to find a horse or tractor to draw the spraying machine, and a man to drive and help to mix the solution. He also makes himself responsible for a clean water supply. The contractor provides the spraying machine and the acid, and supervises operations. The cost varies in accordance with conditions, but may be put at 20s., more or less, per acre. Large areas are naturally contracted for at a reduced price.

The quantity of solution used is normally 100 gal. per acre. The strength varies between 7 per cent. and 20 per cent. of acid—i.e., 7 gal. B.O.V. in 93 gal. of water to 20 gal. B.O.V. in 80 gal. of water. The former serves against Charlock, Chickweed, Cleavers, Speedwell, and many other weeds; Wild Radish, Spurrey and Corn Marigold require 10 gal. B.O.V. in 90 gal. of water; the Corn Buttercup and Poppy about 13 gal. B.O.V. in 87 gal. of water; and so on. The solution is used slightly stronger in damp weather, or after slight rain.

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Spraying may be done any time between the beginning of April and nearly the end of June, according to the state of the crop, winter corn being earlier. It may be said that spraying should take place when the cereal is 4-6 in. in height, and the weeds are in the young seedling stage, when they are much more easily reached by spray and are at the most susceptible age.

Crops not requiring more nitrogen should be sprayed with sulphuric acid rather than dusted with cyanamide.

Dusting with Powdered Cyanamide. If a cereal needs nitrogen as a spring stimulant it may receive it by a dressing of one or other of several fertilizers—including cyanamide, which contains 20.6 per cent. of nitrogen. Cyanamide contains also about 60 per cent. of lime equivalent, and is, moreover, deadly to annual and biennial weeds of cornfields, without seriously injuring the growing cereal. The treatment against weeds is to dust on powdered cyanamide, with a blower if possible, but very satisfactory results can be obtained by using an ordinary distributor if a roll of fine-mesh wire netting is suspended immediately below the outlet. The material is used at the rate of $1\frac{1}{2}$ -2 cwt. per acre, the larger amount against resistant weeds like Corn Buttercup, Poppy, Wild Radish, and Corn Marigold.

The time of application recommended for most weeds is the four rough-leaf stage; with Poppies the rosette of leaves should be the size of a florin. On winter corn, cyanamide may be applied in autumn if weeds are too plentiful.

Cyanamide is best applied when the crop and weeds are damp with dew, as in the early mornings. It is desirable to wear old clothing or overalls, and goggles to avoid getting the dust in the eyes, while it is advisable to oil the hands and arms before work commences, and remove the dust with an oily rag before washing afterwards. Cyanamide should not be allowed to get into cuts, or it may cause smarting and sores.

Many thousands of tons of powdered cyanamide are used in Continental countries for weed destruction in cereals, and the Norwegian authority, Korsmo, states that in 630 experiments with spring cereals, cyanamide gave an average increase of 23.9 per cent. of grain and 12.2 per cent. of straw. It should be added that the new granular form of cyanamide is not recommended for this purpose, but the more widely-known blackish-grey dust.

A NEW INSECT PEST OF CHRYSANTHEMUM

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AND

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During 1938, a fly, hitherto unrecorded in Britain, was found attacking cultivated chrysanthemums in several localities. Adults, which were bred, were submitted to Mr. J. E. Collin, to whom we are greatly indebted for assistance in the identification of the species. Mr. Collin sent specimens to Dr. Hering of Berlin, who stated that the fly was *Paroxyna misella* Lw. (Family *Trypetidae*). (Fig. 1.) The species was apparently described originally from southern Russia (near Sarepta) and it has also been found in the south of France and Spain. It is reputed to have been bred from *Lactuca scariola*, but Dr. Hering thinks this record requires confirmation.

The family *Trypetidae*, which is fairly well represented in Britain, contains a number of species which, in the larval stage, cause leaf-mines, e.g., the Celery Fly, and others are known to cause galls on various plants. The adults are often recognizable by the presence of brown spots and bars on the wings.

NATURE OF ATTACK ON CHRYSANTHEMUM. In some instances injury takes the form of a terminal gall on the stem, involving both the tip of the stem and the surrounding leaves (Fig. 2). The galls examined contained from 1 to 8 larvae in a single cavity. In Middlesex and Scotland a second type of attack (Fig. 3) was observed, the larvae in these instances forming a large "blotch" mine in the leaves. Flies bred from both stem galls and leaf mines appear to be identical, but further critical examination is required before this can be decided. They are, at all events, very similar indeed, though such a diversity of habit among the larvae of a single species is certainly unusual.

The importance of the injury, from the grower's point of view, is, of course, largely dependent upon the intensity of attack. When stem galls are formed, the effect is similar to

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that produced by the usual "stopping," that is, lateral growths are thrown out. This occurs, in many varieties, before it is desirable, with resultant production of inferior or out-of-season blooms. Extensive leaf-mining, especially at an early stage, would appreciably check the growth of the plant and render it very unsightly.

RECORDED CENTRES OF ATTACK. Attacks were first observed at Hampton and Harlington, Middlesex, in June, and at Gillingham, Kent, in July. A further attack occurred at Hampton in August and another was noted near Perth in Scotland in September. In all instances, the nurseries concerned were producing large quantities of chrysanthemums. The variety Friendly Rival was, perhaps, the most frequently attacked, and the larger and softer-wooded varieties appear, in general, to be more susceptible than others. At Hampton, leaf mines only were found; at Harlington, both leaf mines and stem galls occurred; at Gillingham, stem galls only; and in Perthshire, leaf mines alone were present.

Life History. Only a very general outline of the life history is at present known. Adults emerged on July 14 from stem galls obtained from Gillingham and no further attack was observed at this centre, possibly because intensive search was made for all the galls and they were removed. At Hampton, after the original attack in June, a further attack was observed in August, indicating the occurrence of a second generation. Larvae obtained from Scotland in September soon turned to pupae (Fig. 4), and have remained in that condition during the winter, though kept at laboratory temperatures. It seems that there are at least two generations in the year and it is not impossible that another may occur prior to June.

Attempted Control Measures. In Middlesex, nicotine and soap wash appeared to give a good control of the leaf-mining larvae in June-July, but was apparently not altogether successful, in view of the further attack which occurred. This might be explained, however, by the assumption that larvae in galls are less likely to be affected by the wash than those in leaf mines. There is no apparent aperture into the galls, and emerging flies seemed to force their way out between the tightly-folded terminal leaves. At Gillingham, where only a few plants were attacked, the removal of galls seems to have been effective. Imperfectly-formed galls are, however, easily

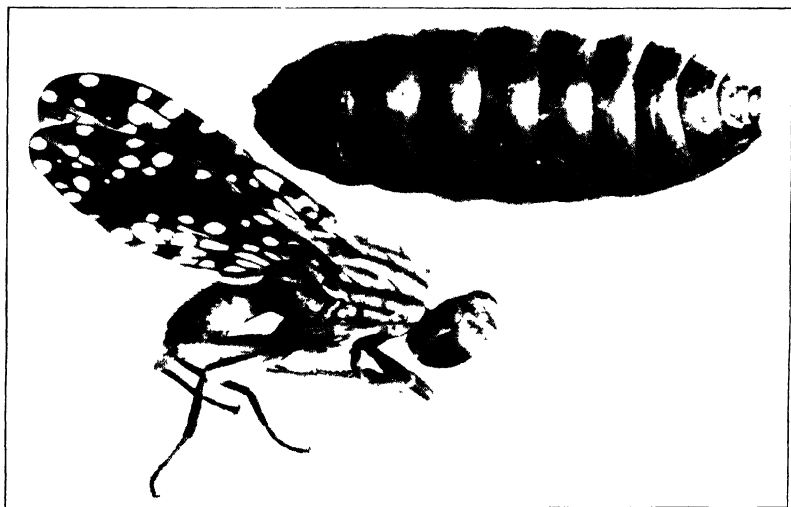
A NEW INSECT PEST OF CHRYSANTHEMUM

overlooked, the stems simply giving the impression that some slight terminal injury has occurred. Any stem showing premature development of lateral growth near the tip, should be regarded with suspicion.

Possible means by which introduction took place were investigated, without throwing any light on the point. At Gillingham, for instance, attacks occurred only on a stock of plants which had been on the nursery for some years and on a seedling raised there; plants which had been brought from outside sources were not affected. On the other hand, an attack of this type could hardly have passed unnoticed, and it is improbable that the fly occurred in this country, at any rate except very spasmodically, prior to 1938. The wide distribution of attacks makes it still more difficult to suggest a mode of introduction.

If established, the insect might become a further pest of some importance on chrysanthemums, and it is desirable to watch for the occurrence of attacks during the summer of 1939.

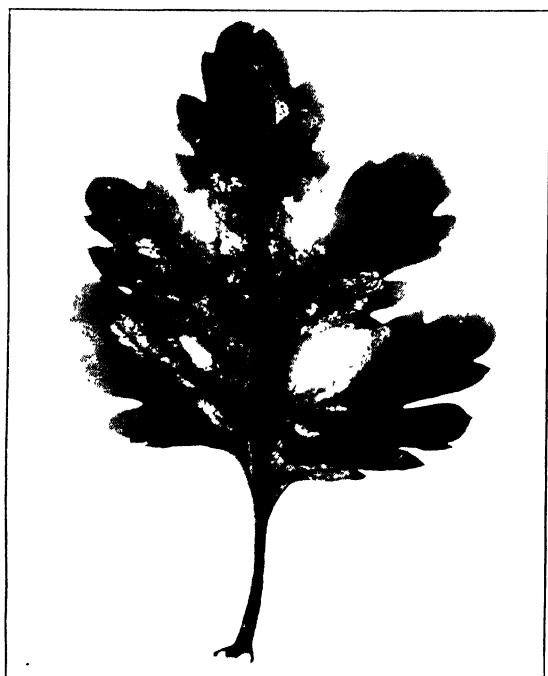
The writers wish to record their thanks to Mr. Duncan, Horticultural Superintendent for Middlesex, who brought attacks in that county to their notice, and who also observed the occurrence in, and forwarded specimens from, Scotland, and to Mr. Elsdon, Kent Education Committee, who sent material from Gillingham.



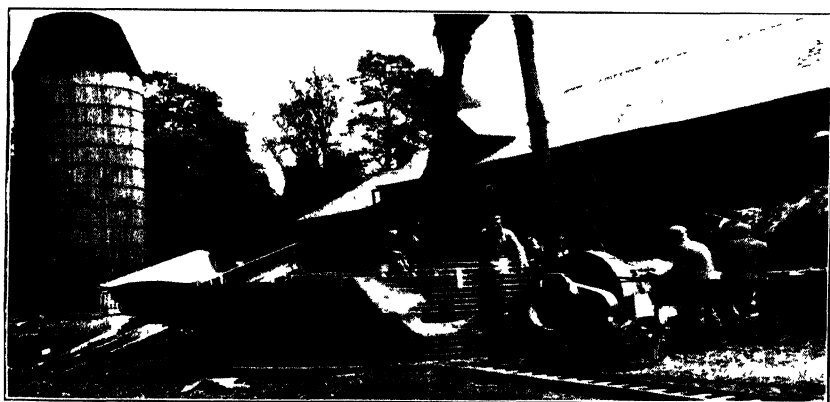
NEW PEST OF CHRYSANTHEMUM
FIG. 1. *Parovyna misella* Lw. Adult 10 and Pupa 10



NEW PEST OF CHRYSANTHEMUM
FIG. 2. *Parovyna misella* Lw. Terminal stem gall in 'Friendly Rival'
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NEW PEST OF CHRYSANTHEMUM
FIG. 3. Larva of *Parovyga nrisella* Lw. in blotch mine
in Friendly Rival



GRASS SHAGE
FIG. 1. Filling a wire and paper silo with cutter and blower.

GRASS SILAGE

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It is a commonplace that much of the grass land of this country is in urgent need of improvement. Advance is undoubtedly being made with the help of the Government subsidies for basic slag and lime, but the root cause of much of the deterioration of pasture during the last decade has been understocking; it appears useless to manure more heavily unless the greater carrying capacity is to be fully utilized. Unfortunately, most farmers are precluded by financial stringency, or the lack of a remunerative market, from increasing the number of stock they carry, and, consequently, the chief hope for them lies in extending the proportion of the year over which their grass will maintain their existing stock. It may be argued that this extension is preferable to increasing the head of stock, because the fodder preserved for winter keep can be cut at flush periods of growth, and that preservation will tend to even out seasonal irregularities. The traditional method of achieving this is to save some fields during the spring flush, and to cut them later for hay.

The value of good hay has been well realized for many centuries: but hay is difficult to make in wet seasons and is impossible to make from the autumn flush of grass. Further, the common practice of allowing grass to mature for hay has a bad effect on the pasture, in that it tends to kill out wild white clover. It is clear that considerable advance can be made by preserving grass when it is in a younger state of growth. Its nutritive value is then much higher than it is at the normal stage when cut for hay, and cutting at this early stage is beneficial, rather than harmful, to the botanical composition of the pasture. Preservation of young grass, rich in protein, leads to a considerable saving of winter cake bills, makes the farm more self-supporting and the country less dependent on imported feeding stuffs. During recent years much has been heard of drying as a method of preserving young grass. The value of this method is still much discussed but it cannot be denied that the capital involved and the incidence of drought are serious handicaps to its spread to farms possessing modest acreages of grass. An alternative method, that does not involve high initial expense, is therefore worthy of serious consideration.

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Preservation in the form of silage seems to meet the requirements: it can be accomplished satisfactorily when molasses or acid is added to the grass, and several cheap forms of silo are available.

Small Silos. In some places concrete silos have been built cheaply with farm labour. The total height of the silo should be about 12 ft., and part of it may be below ground as long as there is no danger of water seeping into the bottom. In some silos the concrete sides are only about 6 ft. high, the construction being completed with a temporary casing of the same height, which is removed after settling has occurred. These over-silos may be made of wood or of wire lined with specially strong paper; in fact, the silo may be entirely made of these materials and may be movable, so that silage may be conveniently stored for feeding either at the homestead or in remote fields to out-wintered stock. Silage stored in the field might also be of extreme value during a summer drought.

The cost of a silo made of wire fencing lined with paper is very low: one with a capacity of 30 tons may be purchased for £9 10s. The life of the paper is only one year, but that of the fencing is several years. These silos are erected in three tiers, each tier of 4 ft. height set within the one below it, so that, after filling, the silage, paper and wire all sink together. For the sinking to be uniform it is important that the silo should be placed on truly level land: the site should be levelled with the aid of a spirit level. It is probably worth while (especially when erection is at a homestead) to make a rim of concrete, 1 ft. wide, on which to rest the lowest tier of wire. Unless the site is naturally very well drained, special provision should be made to lead away the liquid that collects in the bottom of the silo: little expense is involved in putting a grated drain in the site with pipes leading to a low point outside. It is important that part of the lead should consist of a U-shaped pipe that will fill with liquid and thus prevent air from passing up the drain and making the silage mouldy just above the grating.

Material to be Ensiled. Silage often loses in popularity because it belies the fond, but false, hope that the process will make good food out of poor material. This it cannot do, the highest possible success being achieved when as good fodder comes out of the silo as goes into it. If, therefore, it is hoped to replace protein-rich cake, the grass ensiled must be taken from

GRASS SILAGE

useful pasture and must be cut while in the young nutritious stage, i.e., when not more than 8 in. high. During the spring flush this condition will usually be reached in southern districts by about the middle of May, and cutting the pasture at that date has a beneficial effect on its botanical composition, and particularly on the amount of aftermath produced later in the season. This spring grass is undoubtedly of higher feeding value than similar grass grown during the autumn, but useful silage may be made of the latter where growth is luxuriant at that time of the year.

In a wet season, ensiling might be a valuable way of preserving herbage intended for hay, but the silage will then only have a food value (on a dry weight basis) equal to the hay that would have been made under dry conditions: this value will be far superior, of course, to the hay which would be made under wet conditions.

Short grass can be cut satisfactorily with an ordinary hay mower, though better work can be done with a machine having fingers closer together than usual. This cut material should not be allowed to wilt in the field, and where ensiling is used as a supplement to grass drying (i.e., to deal with the peak load) a cut-lift will be used. If this implement is not available, the cut material can be windrowed satisfactorily by an ordinary side-delivery rake: from the windrows the material can be picked up best with 4-pronged forks. Care should be taken that only useful herbage is picked up, and it may be worth while to prepare the field during the preceding winter so that cutting close to the ground may not lead to the incorporation of dirt, stones, manure and old dead grass.

Filling the Silo. The material is best, and most easily, filled into the silo by means of a cutter and blower, but this machine is not available on the majority of farms. In its absence filling may be done by direct forking, by an elevator or by a horse fork. When unchaffed grass is put into the silo, it is very important that each forkful should be shaken out. If it is placed in lumps no amount of treading will displace the air contained in the lumps. The surface of the material should be kept roughly level, with the centre slightly higher, rather than lower, than the outside. Two or three men should be in the silo, so that a thorough trampling can be given, and especial care must be taken to ensure consolidation around the outside.

The instructions for erecting silos of wire and paper, which

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accompany the materials should be followed meticulously. It is an advantage if the top rim of each tier is bent outwards slightly with a pair of pliers, to prevent it from hindering the sinking of the tier above it. The free ends of wire, at the joins of each circle, should be left point upwards, so that they may not catch on the horizontal wires during sinkage, and to avoid their cutting through the paper.

On the completion of the filling, a layer of the special paper, or of sacks, should be placed on the top and covered with soil to a depth of, at the very least, 1 ft. Farmers often appear appalled at the labour involved in covering the top with earth, but if a staging is rigged the work is not so prolonged as might be supposed. It is probably best to load the soil into a cart as the first step, and two men can easily complete the work in a morning. This extra work will make much difference to the quality of the silage, will reduce wastage and is amply justified by the value of the material to be produced. There is a tendency nowadays to aim always for a reduction in labour, but men usefully employed are a very sound investment.

Use of Molasses. The silage may be rendered utterly worthless if appreciable amounts of butyric acid are formed, which will happen if young grass is ensiled alone. It is true that the formation of this acid may be avoided if filling is spread over a long period, so that each layer may heat before being covered with the next, but this leads to a great loss of nutrients. Fortunately, butyric acid is not produced under acid conditions. Good silage can therefore be made with continuous filling if sufficient acid (e.g., hydrochloric, sulphuric, etc.) be added to the material in the process, and this is frequently done on the Continent. There are obvious dangers, however, in this method, both to the men engaged in filling and, if excess acid is used, to the stock eating the silage. The requisite acid condition can be obtained without these attendant risks by the addition of sugar, which is rapidly fermented in the silo to lactic acid, and this method is recommended for general adoption.

In this country, the cheapest form of sugar is molasses, which contains approximately 50 per cent. of sugar. Sugar-beet molasses should be avoided because of the betaine it contains and on account of its laxativeness. Only cane molasses should be used. The amount used should be from 3 to 4 per cent. of the weight of green herbage ensiled. The

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higher the protein content of the herbage, the greater the proportion of molasses which should be added, but as an excess of molasses is not harmful, and adds to the feeding value of the silage, it is best to use it generously. If possible one load of grass should be weighed so that the right amount of molasses to be added to each load can be calculated. In the absence of weighing facilities it may be assumed that an ordinary farm cart will normally hold about half a ton of green grass, since it is difficult to load the cart very high.

Where a cutter and blower is used, the barrel of molasses should be placed so that a thin stream pours on to the material as it is being fed into the cutter; this gives an almost perfect mixture of molasses and herbage. With other methods of filling, the molasses, diluted with an equal volume of water, may be sprinkled over the material in the silo with an ordinary watering can. The solution should be made with hot water, if available: if cold water is used the mixture must be kept well stirred. It should be remembered that butyric acid will be formed at all places untouched by molasses, and consequently the layers of grass should never exceed a depth of 4 in. without being sprinkled. Each layer should afterwards be thoroughly trampled. The spraying can, of course, be done by one of the men trampling in the silo. With a 16-ft. diameter silo, one cartload of grass will give a layer of approximately 4 in. thickness. The molasses will tend to soak down the silo, and an extra spraying should be given to the top two or three layers. As long as efficient drainage has been provided, the molasses may be diluted as much as convenient, but if drainage is not very efficient and the grass is wet no more water should be used than is necessary to make the molasses run through the rose of the watering can. The cost of molasses is in the neighbourhood of £5 per ton, and rather less than 1 ton is required for a 30-ton silo (16 ft. diameter).

Using the Silage. The main sinking of the silo occurs during the first month after filling, and after that very little effluent emerges from the drain; it is therefore quite safe to feed the silage at that time, though, in general, there will be a much longer interval between filling and use. Once the silo is opened, it must be remembered that any silage exposed to the air for more than 3 days (2 days in hot weather) may become mouldy to a depth of 2-3 in. and unfit to feed. It is therefore essential to use the silage continuously and sufficiently rapidly

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after a start has been made. The material should be taken from the whole surface in thin layers, but if sufficient stock are not being fed to require a depth of 4 or 5 in. per week it is better to use only half the silo at a time, rather than allow the material continuously to mould ahead of removal. Where only half the silo is used, a hay knife should be employed to produce a solid face to the half that is left. This exposed face will, of course, become mouldy, but when cut in this way the mould will not extend more than 2 or 3 in. into the face. Another method is to cut the silo like a cake, but this necessitates removing the sides of the silo, with a possible attack by mould all round the circumference. As the best method is undoubtedly that of taking layers from the whole of the top, it will be realized that two small silos would be preferable to one large one when the consumption rate is low, provided they are not so small that there is serious wastage round the outside. Two silos of 11 ft. diameter will hold approximately as much as, and would be preferable in such circumstances to, one silo of 16 ft. diameter, though the initial cost would be slightly increased.

Value of Product. Silage is most commonly produced for feeding to cattle, and in Holland as much as 70 lb. per head per day is given to dairy cows. At Cambridge, as much as 35 lb. per head per day has been successfully fed to 18-month-old stores. In feeding trials carried out in the autumn of 1938, 10 lb. of silage was found to be fully equal to 3 lb. of dried sugar-beet pulp for store cattle. This statement somewhat underestimates the value of silage, which, of course, provides much more protein than the pulp. On this basis, the value of silage would be at least 30s. per ton. The cost of converting the young grass into silage, assuming the wire and paper silo to be used, and including the cost for the carting, filling and covering with earth, and also the molasses, would be of the order of 10s. per ton of silage. This figure should not be liable to much variation, since there need be no broken time due to inclement weather; in fact, it might be a useful method of employing men during rainy weather. The costs are thus adequately covered by the value of the product, and the considerations advanced at the beginning of this article lead the writers to think that the ensiling of young grass is a process which should play a large part in British agriculture.

THE ECONOMICS OF MACHINE-MILKING

A. BRIDGES,

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The problem of substituting machinery for hand labour in milking has long occupied the attention of milk producers. It was natural that this should be so. Cows have to be milked twice or perhaps thrice a day at definite times. Wyllie has put it aptly: "It is always milking first, all other things second." In short, milking is, in farming language, the most "binding" job there is on the farm.*

The increasing difficulty of getting experienced milkers, the interference which milking makes with other farm work, and the irksome nature of the work have been contributory causes of the change to machine milking. But apart from these, the milking process is a substantial part of the labour cost of milk production. Further, for the last ten years, wage rates have been rising relative to the value of milk and milk products. It was not surprising, therefore, that farmers should have sought ways and means of keeping their labour costs in line with prices, and the milking machine offered an alleviation of their situation. On account of the dearness of labour further mechanization of other branches of farming was also taking place, and the forces were strong, therefore, for reducing labour on the live stock wherever this was possible.

TABLE I. SALES OF MILKING MACHINES

			<i>Index of Sales</i> 1925 = 100	<i>Percentage Increase</i> <i>Over Previous Year</i>
1925	..	..	100	—
1926	..	..	315	215
1927	..	..	467	48
1928	..	..	832	78
1929	..	..	1,045	26
1930	..	..	1,155	10
1931	..	..	1,556	35

There is no official evidence of the numbers of milking machines in use on farms in England and Wales, and the information available is not altogether satisfactory. Partly because of the reasons given, and partly because of marked improvements in the construction and working of machines, there is no doubt that a very striking increase has taken place in the use of milking machines during the last ten years. Some indication of the growth may be gathered from the above figures of sales by two firms.

* *The Economics of Machine Milking.* James Wyllie. *Transactions of the Yorkshire Agricultural Society*, 1931.

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Since 1931, new machines have been sold in increasing numbers. From 1934 onwards data from a sample of between 400-500 herds in England and Wales show clearly the trend of events in the process of milking.

TABLE II. INCREASE IN MILKING MACHINES ON 400-500 HERDS

	<i>Number of Herds</i>	<i>Herds with Milking Machines</i>	
		<i>Number</i>	<i>Percentage of Total</i>
1934-5	490	105	21.4
1935-6	437	122	27.9
1936-7	437	141	32.3
1937-8	415	150	36.1

It is safe to say that at the present time about 8 per cent. of the herds and 15 per cent. of the cows and heifers in milk and in calf in England and Wales are milked by machine. Four or five years ago the corresponding figures might have been 5-6 and 11-12 per cent. respectively.

Milking machines are to be found in all the dairying districts of England and Wales, although they are less numerous in areas, Devon and Cornwall, for example, where the herds are small and family labour predominates. This is understandable. The greatest economy from the use of the machine is secured in the large herds. It is also the large herds which are wholly, or almost wholly, tended and milked by paid labour, and the scarcity of labour or high wage rates, or both, would favour the introduction of the machine. The following table illustrates that a greater proportion of large herds than small herds is milked by machine.*

TABLE III. RELATION OF SIZE OF HERD TO NUMBER OF MILKING MACHINES, 1937-8

<i>Size Group Number of Cows</i>	<i>Number of Herds</i>	<i>Herds Milked by Machine</i>	
		<i>Number</i>	<i>Percentage</i>
Up to 10	16	1	6.3
11-20	90	6	6.7
21-30	116	34	29.3
31-40	66	35	53.0
41 +	127	74	58.3
TOTAL	415	150	36.1

* Material for the remainder of this study has been secured under a scheme for the investigation of the economics of milk production in England and Wales which has been in operation since 1934. See *Milk Investigation Scheme. Costs of Milk Production in England and Wales. Interim Reports* Nos. 1, 2 and 3. Oxford, Agricultural Economics Research Institute.

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There are, however, considerably more small herds than large herds in the country, and although the proportion of small herds milked by machine may be low, it may represent a very large number of small herds.

As previously stated, the main reason for the substitution of machine for hand-milking is to economize in labour, and there is ample evidence to show that by the use of a machine the cost of labour in milk production is reduced. The following table gives a comparison between the cost of labour on herds milked by hand and those milked by machine, for the three years 1934-35 to 1936-37.

TABLE IV. COST OF LABOUR IN MILK PRODUCTION ON HERDS MILKED
(A) BY MACHINE, AND (B) BY HAND

	Size of Herd Groups—Cows					
	11-20	21-30	31-40	41-50	51 +	All Herds
(A) HERDS MILKED BY MACHINE :						
Labour cost in d. per gal., 1934-5	2.16	1.97	1.99	1.96	1.71	1.86
5-6	1.97	2.07	1.99	2.00	1.81	1.92
6-7	2.36	2.21	2.01	1.87	2.06	2.02
(B) HERDS MILKED BY HAND :						
Labour cost in d. per gal., 1934-5	2.42	2.33	2.41	2.30	2.08	2.29
5-6	2.37	2.38	2.27	2.25	2.15	2.28
6-7	2.36	2.47	2.48	2.29	2.43	2.42

On average the labour cost was from 0.36 to 0.43d. per gal. lower on the machine-milked herds, the difference in the large herd groups tending to be greater than in the small. Although the labour cost was lower, the total cost of milk production was rather higher on machine-milked herds. (See Table V.)

From this data it would seem that the economy in labour by the use of the machine is lost in other directions. The differences in the net farm costs between the two groups are not large, however, and it may be that the introduction of the machine has effected a saving on those farms using the machine, thus bringing their costs more into line with other producers more favourably situated. An approach to the problem of the economy of machine-milking was made, therefore, in another way. This was done by taking the costs of

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TABLE V. NET FARM COSTS IN MILK PRODUCTION ON HERDS MILKED
(A) BY MACHINE, AND (B) BY HAND

	Size of Herd Group—Cows					
	11-20	21-30	31-40	41-50	51 +	All Herds
(A) HERDS MILKED BY MACHINE :						
Net farm cost in <i>d.</i>						
per gal., 1934-5 ..	9.67	9.81	9.88	10.56	9.02	9.56
5-6 ..	7.80	9.46	9.41	9.63	9.07	9.27
6-7 ..	10.57	10.35	9.77	9.20	10.15	9.82
(B) HERDS MILKED BY HAND :						
Net farm cost in <i>d.</i>						
per gal., 1934-5 ..	9.55	9.35	9.52	9.65	8.91	9.35
5-6 ..	9.10	9.03	8.90	8.85	8.65	8.88
6-7 ..	9.21	9.43	9.77	9.42	9.10	9.36

milk production on a group of farms before and after a milking machine was introduced and comparing the results. In this way it was believed a more precise picture could be drawn.

The following part of the study refers to 24 herds in various parts of England for which milk costs are available for 3 years. On 12 of these farms machines were installed in the year 1935-36, and the remainder in 1936-37. There were 11 herds having under 30 cows and 13 with herds over 30 cows. Perhaps one of the outstanding features associated with the introduction of the machines is that on 8 farms the size of the herd increased appreciably. Of the 11 small herds, 5 increased the number of cows by an average of 35 per cent. Of the 12 large herds only three increased in numbers by an average of 23 per cent. These increases took place without any addition to the charges for dairy buildings, so that no extra accommodation had to be provided. Three of the small herds and one of the large herds decreased in size, but this was not associated with the introduction of the machine.

In the table opposite an examination is made of the labour costs in the year before the machine was introduced and in the year after, when the full effect of the change would have taken place.

The details of the total labour cost and cost per cow in the two years are given for the two sizes of herd groups, distinguishing those herds which remained of the same size, those

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TABLE VI. LABOUR COSTS ON 24 HERDS BEFORE AND AFTER THE INSTALLATION OF MILKING MACHINES

1934-5 or 1935-6				1936-7 or 1937-8		
No. of Herd	No. of Cows	Labour Cost		No. of Cows	Labour Cost	
		Total £	Per Cow £		Total £	Per Cow £
SMALL-HERD GROUP						
(a) Herds with No Change in Size :						
1	15	132	8.8	15	168	11.2
2	16	79	5.0	16	70	4.3
3	25	160	6.3	24	149	6.2
	56	371	6.6	55	387	7.0
(b) Herds Increasing in Size :						
4	14	80	5.7	25	68	2.7
5	26	236	9.1	39	268	6.8
6	26	182	7.0	33	167	5.1
7	27	184	6.7	33	180	5.5
8	28	192	6.9	34	177	5.2
	121	874	7.2	164	860	5.2
(c) Herds Decreasing in Size :						
9	24	169	7.1	20	183	9.1
10	29	235	8.2	24	258	10.7
11	29	193	6.7	24	173	7.2
	82	597	7.3	68	614	9.0
LARGE-HERD GROUP						
(a) Herds with No Change in Size						
12	31	265	8.5	30	205	6.8
13	39	223	5.7	38	179	4.7
14	41	241	5.8	41	210	5.2
15	41	195	4.7	41	205	5.1
16	43	259	6.0	45	162	3.6
17	46	277	6.0	46	236	5.1
18	49	355	7.3	50	361	7.2
19	49	414	8.5	49	313	6.4
20	54	244	4.5	54	184	3.4
	393	2,473	6.3	394	2,055	5.2
(b) Herds Increasing in Size :						
21	38	334	8.8	45	194	4.3
22	40	258	6.5	47	165	3.5
23	45	260	5.8	59	198	3.4
	123	852	6.9	151	557	3.7
(c) Herds Decreasing in Size :						
24	69	283	4.1	48	235	4.9

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which increased and those which decreased in size. Dealing first with the herds which showed no change in size, in the small-herd group very little change in labour costs took place. In one herd the cost of labour increased by £36; and in the other two it declined by £9 and £11 respectively, equal to £0.7 and £0.1 per cow. In the large-herd group the cost of labour declined in seven herds by £60, £44, £31, £97, £41, £101 and £60 respectively, and in two herds it increased by £10 and £6. Over the 9 herds there was a reduction of £418, equal to £46 per herd and £1.1 per cow. Individually the differences ranged from a reduction of £2.4 per cow to an increase of £0.4 per cow.

In the herds which increased in size the economy secured by the introduction is more definite and is of considerable dimension. In the five small herds the total wages cost, which was £874 for 121 cows, declined to £860 for 164 cows, the cost falling from £7.2 to £5.2, or by £2 per cow. Individually, the labour cost per cow was reduced by £3, £2.3, £1.9, £1.2 and £1.7 respectively. In three herds in the large-size group even greater reductions are shown. These were £4.5, £3 and £2.4 per cow, with an average of £3.2. The total wages fell from £852 for 123 cows to £557 for 151 cows. One only of these eight herds paid more in *total* labour costs. On this herd the cost of labour was £236 for 26 cows in 1934-35 and £268, or £36 more, for 39 cows in 1937-38.

The effect on the cost of labour of introducing a machine may therefore be summed up as follows:—

- (a) Small herds, with no change in size, made little if any saving in labour costs.
- (b) Large herds, with no change in size, reduced labour cost by £1.1 per cow. Labour costs per cow in this group were low prior to change.
- (c) Small herds, increasing in size, reduced labour cost by £2 per cow.
- (d) Large herds, increasing in size, reduced labour cost by £3.2 per cow.
- (e) From these facts it may be deduced that large herds effect a greater economy by machines than small herds; and
- (f) Herds which increase in size as the result of the introduction of the machine effect the largest reduction in labour costs.

No precise information of the total costs of the running, upkeep and depreciation of the milking machines on these herds is available, but the following figures represent what is believed to be average costs at the present time for repre-

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sentative herds, for machines where petrol is the source of power:—

TABLE VII. COSTS OF RUNNING AND UPKEEP OF MILKING MACHINES

Herd Size	Milking Machine Costs			
	Power*	Wearing Parts	Depreciation†	Total
No. of Cows	£ s. d.	£ s. d.	£ s. d.	£ s. d.
20 ..	7 5 5	3 4 0	9 0 0	19 9 5
30 ..	9 13 11	4 16 0	11 0 0	25 9 11
40 ..	9 13 11	6 8 0	13 0 0	29 1 11
50 ..	12 2 5	8 10 0	15 0 0	35 12 5

* Petrol engine. Where electricity is used the nett cost of power depends on the rate per unit, but the cost at 1½d. a unit is considerably below the cost when petrol is the source of power.

† 10 per cent. on machine and 5 per cent. on engine.

Using these figures, it is possible to give a reasonable picture of the economy of the machine in relation to the labour position before and after the machine was introduced. (Table VIII on p. 70.)

It is clear that on the three small herds, which show no increase in size, the costs were higher after the machine was installed. With two exceptions, on all the others the cost of the machine is less than the saving of labour, sometimes by considerable amounts. It would appear, therefore, that unless there was any consequent loss in other directions, the machine effected a considerable economy for most of these herds.

It is often claimed that the milk yield is less with machine milking, and that there is a greater risk of depreciation of the cows through the possible spread of disease. The position in regard to the former may be studied by comparing the yields of the herds, which did not change in size, in the year before and in the one after machine-milking was introduced (Table IX).*

Six herds showed an increase and six a decrease in yields. A comparison of two years is not very satisfactory for measuring changes in individual herds for such a variable

* Only those herds remaining of the same size are taken for the yield and depreciation comparisons. The introduction of new stock, as well as other complications, made it dangerous to make a comparison for the herds increasing in size. On these herds the yields were lower on average, although two herds showed small increases, and it may be that a temporary loss of yield has to be faced in such circumstances in a change to machine-milking.

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TABLE VIII. NET SAVING IN LABOUR BY MACHINE MILKING : 20 FARMS

	No. of Herd	No. of Cows	Increase or Decrease in Total Labour Costs	Estimated Cost of Machines*	Net Saving in Labour by Machine-milking
			£	£	£
SMALL-HERD GROUP :					
<i>(a) Herds with No Change in Size :</i>					
	1	15	+ 36	19	55**
	2	16	— 9	19	10**
	3	25	— 11	25	14**
<i>(b) Herds Increasing in Size :</i>					
	4	25 (14)†	— 74†	25	49
	6	33 (26)	— 64†	25	39
	7	33 (27)	— 41†	25	16
	8	34 (28)	— 57†	25	32
	5	39 (26)	— 87†	29	58
LARGE-HERD GROUP :					
<i>(a) Herds with No Change in Size :</i>					
	12	31	— 60	25	35
	13	39	— 44	29	15
	14	41	— 31	29	2
	15	41	+ 10	29	39**
	16	43	— 97	29	68
	17	46	— 41	36	5
	18	49	+ 6	36	42**
	19	49	— 101	36	65
	20	54	— 60	36	24
<i>(b) Herds Increasing in Size :</i>					
	21	45 (38)	— 202†	36	166
	22	47 (40)	— 140†	36	104
	23	59 (45)	— 144†	45	99

* To the nearest £.

† In these cases the relative economy in labour is taken to be the cost of labour per cow when hand milked multiplied by the increased herd less the cost of labour when machine milked.

‡ Figures in parentheses refer to original size of herd.

** Increased cost.

factor as yield, and for this reason a better guide to the probable effect of machine milking is to take the yields for the twelve herds as a whole.

In the year prior to the introduction of the machine, the total yield of milk from 449 cows was 315,285 gal., and in the year after it amounted to 311,614 gal. The decrease was 3,671 gal., or about 8 gal. per cow. The average difference of 8 gal. per cow is very small and is not significant. Allowing, however, that the yield decline of 8 gal. was attributable to

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TABLE IX. YIELDS (IN GALLONS) PER COW BEFORE AND AFTER INTRODUCTION OF MILKING MACHINE: HERDS WITH NO CHANGE IN SIZE

Herd No.	Yield per Cow per Annum		
	Hand Milking	Machine Milking	Increase + or Decrease -- in Yield
1	1,003	825	— 178
2	545	695	+ 150
3	681	582	— 99
12	740	716	— 24
13	617	643	+ 26
14	834	891	+ 57
15	549	665	+ 116
16	762	695	— 77
17	680	651	— 29
18	775	735	— 40
19	722	841	+ 117
20	615	652	+ 37
	702	694	-- 8

the machine, the net reduction of income—with milk at 1s. a gal. and foods at $\frac{3}{4}$ d. a lb. (4 lb. to 1 gal. of milk)—would amount to 6s. per cow, equal to £6, £9, £12 and £15 on herds of 20, 30, 40 and 50 cows respectively.

As to the cost of herd depreciation, no very precise statement can be made. This is a charge which fluctuates very considerably from year to year and it is unwise to offer a comparison between the costs of two single years on individual farms. In the aggregate the depreciation cost on 449 cows in the herds which did not change size was £953 in the year after, as compared with £1,215 in the year before the machines were introduced. This decline was 11s. 8d. per cow and 0.2d. per gal.* On the other hand, a comparison for the same years for a much larger number of herds also showed a decline of 0.15d. per gal.,† indicating that there was a general factor operating to reduce the depreciation charge. Therefore, the machine cannot be given the benefit of the lower figures. However, it

* On the 8 herds which increased in size, the depreciation was £797 for 244 cows (£3 5s. 4d. per cow) when milked by hand and £674 for 315 cows (£2 2s. 10d. per cow) when machine-milked.

† In 1934-5 the depreciation on 490 herds was 0.98d. per gal.; in 1936-7 on 437 herds it was 0.83d. per gal. See *Costs of Milk Production in England and Wales*. Interim Reports Nos. 1 and 3, Oxford Agricultural Economic Research Institute. Price 2s. 6d. and 1s. 6d.

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is safe to say that, so far, the use of the machine had not increased the depreciation per cow on these herds as a whole.

* * *

For the larger herds and those which increased in size there was a saving in labour cost, often a considerable one, by the use of the machine. The comparisons of the labour cost before and after the installation of a machine do not measure the full saving which has occurred in this item. The level of wage rates has been rising steadily and the farmers concerned have thus avoided the payment of the higher wages for men displaced by the machine.

From the data for these herds—admittedly, not a large sample—there is no evidence of falling yields or increasing depreciation of the cows. There are, of course, circumstances in which there might be serious loss of yield and spread of disease by machine-milking. With the machine there are fewer hands in the cowshed and its use may lead to the development of the “ factory process ” mind. Attempts to speed up a function which is not governed by mechanical considerations, and, unlike good hand-milking, a lack of individual attention in the milking and feeding of the cows, may give anything but satisfactory financial results. In machine-milking there is a greater need for vigilance and attention to the cows on the part of each man, and for a higher degree of managerial efficiency. Practical experience would seem to indicate that the success of mechanical milking largely depends on the efficiency of farm labour.

THE TREATMENT OF PLANTS AND TREES BY INJECTION

D. AKENHEAD,

Imperial Bureau of Horticulture and Plantation Crops

Man has always wanted to go one better than Nature and show his originality, but perhaps the modern lover of the bizarre who buys tulips and freesias ruined by the injection of dyes would refrain from supporting that work of desecration were he only to realize there is nothing new under the sun, and that directions for imparting yellow or blue colours to roses were given in a work of Hadj de Granade written in the 12th century.

Some centuries later, Leonardo da Vinci, who, one likes to think, would have scorned the practice just mentioned, noted that injection could be put to a use more practical and apposite to the age in which he lived, in short, that the insertion of arsenical salts in a hole made in a tree would render the fruits poisonous.

But as in warfare arrows gave place to poisoned arrows and poisoned arrows to poison gas and incendiary bombs, so horticulturists, too, have always sought perfection in the attack on their problems, and in the midst of their ploughing and dunging and pruning have yearned for a short cut which would achieve the desired end with less effort.

In the 19th century, largely as the result of physiological investigations into the ascent of sap and similar problems, injection experiments became frequent, and in 1886 Sachs, one of the most renowned physiologists of his day, published an account of the injection of iron salts into chlorotic acacia trees.

Advance thereafter, though spasmodic, became general, and considerable work was done in Russia, Germany, France, Italy, U.S.A., and England. The aims of the different workers were diverse, their methods even more so. They appear to have fairly frequently misunderstood one another and controversy raged on many technical points, notably as to whether or not it was necessary to exclude air from the injection hole.

In recent years, Dr. W. A. Roach* of East Malling has

* Roach, W. A. *Plant Injection for Diagnostic and Curative Purposes*. (Foreword by Prof. V. H. Blackman, Sc.D., F.R.S.). *Technical Communication* 10 of the Imperial Bureau of Horticulture and Plantation Crops, East Malling, Kent, England, 1938. Pp. 78, plates 2, text figures 47, bibl. 102. Price 5s.

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turned his attention to this fascinating subject, and profiting to the full from the results of early workers he has already developed methods of technique suitable for use under a number of different circumstances.

In the past, with one or two notable exceptions, each worker appears to have been concerned with one particular problem such as chlorosis, the effect of a particular chemical on tree growth, the cure of phylloxera, etc. Only one method, or, at most, two or three have been tried, and there the matter has rested. Dr. Roach, on the other hand, has not been content to try one or two methods; he has tried them all, improved on many and evolved new ones.

His own injection experiments have now been in progress for more than seven years on material ranging from the strawberry plant to fully grown apple and plum trees, and reports on most of them are available.* As the result of these earlier publications he found himself overwhelmed with inquiries as to amounts, methods and results likely, and it is largely to answer these inquiries that he consented to publish his own experience in the form of a Technical Communication which appears likely to be the standard guide to the subject for some time.

Since, however, he is very far from suggesting that injection is the panacea for all tree ills, it may be useful to consider what benefits are likely, in his opinion, to arise from its carefully considered use.

Its most important use is the diagnosis of mineral deficiencies. Dr. Roach's work has indicated that each of the common nutrients produces the same effects on plants whether injected artificially or absorbed by the roots in the usual way. Thus, "by one of the methods described a single interveinal area (on a leaf) may be injected with a test liquid, which becomes so distributed that the treated area is separated from the untreated areas on each side of it by a secondary vein; this separation is so sharp that the slightest change in colour or texture of the treated area is easily detected, permitting mineral deficiency to be diagnosed in a week or even less. . . . the probabilities are 1,000 to 1 against the response shown by a single treated area being due to chance; and if the experi-

*East Malling Annual Reports for 1928-30, 1933, 1934, 1935, 1936.

Annals of Applied Biology, 21, 319-43.

Journal of Pomology and Horticultural Science, 12, 151-66.

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ment be carried out in duplicate the odds become a 1,000,000 to 1"

Having thus diagnosed his deficiency by watching the response of the leaf to particular salts in solution, the fruit farmer may decide to make good the deficiency by ordinary cultural methods. But this may entail a complete change in cultural practice, and where, for instance, it is wished to increase soil organic matter, the release of minerals from the solid part of the soil into solution is likely sometimes to be slow. Meantime it is suggested that at any rate the more seriously affected trees may be quickly cured by injection. In fact, at the present time, in extreme cases of chlorotic trees growing in excessively calcareous soils, deterioration in soil composition has gone so far that injection appears to offer the only possibility of a cure.

Where fruit is grown on drift soils which vary immensely from place to place even in the same orchard, ordinary manurial experiments are both extremely difficult to plan and somewhat unreliable in their results. There is a great opportunity here for the use of injection methods.

Again, injection has already elucidated the cause and provided a cure for certain boron deficiency symptoms of apple in New Zealand and Canada. In other cases where there has been no response to boron injection the method still offers the quickest diagnosis of the trouble and it is proposed to seek cures by injecting different compounds, initial guidance as to what substance to use being obtained by chemical analysis of healthy and affected plants.

Further, there is reason for thinking that modern technique may eventually allow the treatment of certain diseases and pests by the injection of particular compounds. Encouraging results have already been achieved with leaf hoppers, red spider, silver leaf, apple mildew and woolly aphid.

Again, Dr. Roach's own work has shown that the rootstock influences the mineral composition of the scion worked on it, hence in any attempt to explain the effect on the biological character of the scion it becomes desirable to test the effects on a tree of each of the twenty odd elements which occur on it, most of them in minute amounts. Injection methods should make this comparatively easy.

Finally, one of the many urgent storage problems is to determine the reasons underlying good keeping quality. Injection affords a method of altering the constituents of the

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fruit itself considerably and enabling the effect of such variations on respiration and keeping qualities and resistance to fungal invasion to be tested.

It will be seen that the field open to the injector is large. He has, moreover, a wide choice of methods since injection may be made with equal success into interveinal leaf areas, into tree trunks, or at a large number of intermediate positions to suit individual circumstances. To give an example, the shoot tip method, in which either the shoot tip is bent over into a nutrient solution or the cut end of a stiff shoot is connected with a glass tube containing solution, has been successfully used in the cure of a powdery mildew infection of apples and in the diagnosis of peach chlorosis in the greenhouse and of faulty iron nutrition in Kentish cherry trees. In whole tree injection the choice of position of the injection hole offers a nice problem, which is discussed by Dr. Roach at considerable length. This method can be used for diagnostic and experimental work and is to be preferred to the branch method when a large experimental unit is advantageous. It has already been used to vary the composition of a number of fruit lots destined for chemical, physiological and storage tests after picking. Under certain circumstances, mentioned previously, it would appear to offer a chance of quickly restoring declining trees in the commercial orchard.

So wide a choice of methods might indeed be alarming were it not for the very useful notes given by the author on the practical application of each method and its adaptation to meet particular problems. His technique and apparatus are, moreover, illustrated in detail.

Injection is not confined to one problem or one type of crop and the methods set out in this manual are equally applicable to temperate and to tropical crops. They have already been successfully applied to such crops as tea and coffee, and at the present time Dr. Roach is himself using them in South African orchards.

That the path of the injector is not smooth is obvious from the comparative failure of previous investigators to achieve uniform or even frequent success. Yet it would seem that by generously showing all his tricks and warning the innocent how best to avoid pitfalls Dr. Roach not only offers the county horticultural adviser an additional diagnostic weapon, but also opens up to the investigator a vista of far-reaching progress in rootstock, storage, manurial and even soil problems.

IMPROVING THE QUALITY OF HAY

A. H. LEWIS,

Jealott's Hill Research Station, Bracknell, Berks.

A great deal of the hay crop of Great Britain has a very low protein content. A number of samples taken in 1935 from different parts of the country indicated an average crude protein content of only 7.58 per cent.¹ This figure is only slightly higher than that quoted in *Rations for Livestock*² (7.5 per cent.) for poor meadow hay. It is obvious that any means whereby the protein content of hay could be economically increased would be of considerable importance.

In 1937, Sprague³ published a note entitled, *Improving the protein content of timothy by application of soluble nitrogen fertilizers 10 to 20 days before harvest*. In this note he called attention to the fact that improvement in the protein content of forage, particularly hay, is an important problem in the humid areas of U.S.A., and he pointed out that efforts to improve the quality of grass hay by applying nitrogen fertilizers in winter or spring usually produce substantial increases in yield and in total protein per acre, but only minor increases in percentage protein content when the crop is harvested after the blooming period. In 1930, he conceived the idea of trying the effect of applying soluble nitrogen fertilizers ten to twenty days before harvest. He considered that this period would be long enough for uptake of the nitrogen and its conversion to organic forms. He found in an experiment that the protein content of timothy hay was raised from 6.7 per cent. up to 9.11 per cent. by applying 24-33 lb. nitrogen per acre ten to twenty days before harvest.

Sprague and Hawkins⁴ followed up this preliminary note by a full account of the experiments in 1938. The results fully confirmed the previous finding, and proved definitely that the proportion of nitrogen in inorganic form in the hay was not increased by late application of nitrogen fertilizers, i.e., all the nitrogen absorbed by the crop was built up into organic compounds. The average recovery in the hay crop of the added nitrogen was about 25 per cent. when applied ten days before harvest, and 35 per cent. when applied twenty days

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before harvest. Aftermath growth was also increased, and the total recovery in the two crops was about 40-50 per cent. for both dates of application; this is as high as the recovery when nitrogen is applied early to increase yields. They found that the effectiveness of the added nitrogen varied somewhat from season to season and, under their conditions where the rainfall in May and June was about six inches, the recovery in the hay crop of added nitrogen was 35 per cent. when the rainfall was well distributed and 27 per cent. when a drought occurred from May 20 to June 12.*

Details of Experiment. An experiment was carried out at Jealott's Hill in 1938 to get information on the effect of late applications of nitrogen to hay under British conditions. The sward consisted mainly of perennial ryegrass, cocksfoot and wild white clover with smaller amounts of Yorkshire fog, meadow grasses and weeds. The area had been cut for grass drying three times in 1936, 2 cwt. of nitrochalk per acre being applied for each cut. In the autumn of 1936 dung was applied at 15 tons per acre. In 1937, the area was dressed with 2 cwt. nitrochalk per acre and cut for hay; a further 2 cwt. nitrochalk per acre was given, and the aftermath was cut and carted off. A basal dressing of 3 cwt. superphosphate and 2 cwt. muriate of potash per acre was given on March 16, 1938.

Three nitrogenous fertilizers, sulphate of ammonia, nitrate of soda and nitrochalk, were compared. These fertilizers were applied at two rates of application (17.4 and 34.7 lb. nitrogen per acre) and at two times (10 and 20 days before harvest). Each main treatment (0, 1 and 2 units of the three fertilizers) was replicated four times, and the plots were subdivided in half for time of application. The sub-plots were each 1/400th acre in area. The first dressing of nitrogen was given on May 20 and the second on May 30.

Rainfall. The spring was abnormally dry, only 0.25 in. of rain falling in March and 0.08 in April. No rain fell in May until the 25th, which was five days after the first application of nitrogen. The daily rainfall from May 25 to June 1 was 0.17, 0, 0.05, 0.75, 0.19, 0.04, 0.18 and 0.05 in. Thus, apart from a heavy downpour on May 28, rainfall was slight. From June 2 until June 9, when the plots were cut, no rain fell.

* The crop was cut on July 7 in both years.

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Yield. The plots were cut on June 9. The crop was not made into hay, but was weighed fresh, and samples were taken for dry matter and chemical determinations.

There were no significant differences in yield of dry matter, i.e., the nitrogen fertilizers, regardless of rate and time of application, did not affect yield. The mean yield of dry matter* was 22.9 cwt. per acre, which was fairly good considering the dry season.

Crude Protein Content. The figures given in Table I show that the nitrogen fertilizers markedly increased the percentage of crude protein in the crop. There were no significant differences between the three types of nitrogen fertilizer or between dates of application.

TABLE I.—PERCENTAGE CRUDE PROTEIN ($N \times 6.25$) CONTENT

When Applied (Days Before Harvest)		10		20	
Lb. N applied per acre	..	17.4	34.7	17.4	34.7
Sulphate of ammonia (4)	..	10.77	11.84	10.63	11.14
Nitrate of soda (4)	..	10.11	11.77	10.28	12.38
Nitrochalk (4)	..	9.96	11.63	10.00	11.16
Mean (12)	..	10.28	11.74	10.30	11.56
No nitrogen (12)	..	..	8.69	..	..

Figures in brackets refer to number of replicates.
Standard error of mean of 4 = 0.388.

The following results show that the increases in crude protein content and in yield of protein per acre were proportional to the amount of fertilizer applied :—

Nitrogen Applied lb./acre		Crude Protein Percentage of Dry Matter		cwt./acre
0	..	8.69	1.94	
17.4	..	10.29	2.30	
34.7	..	11.65	2.77	
Significant Difference ($P = 0.05$)		0.46	0.11	

Fate of Assimilated Nitrogen. It is essential to know whether nitrogen applied so late to the hay crop is converted into protein or whether a high proportion is present in the form of simpler organic compounds such as amides or even in inorganic form (ammonia or nitrate). The results given in

* Yield data and chemical analysis are given in terms of oven-dried material. Hay contains, on an average, about 15 per cent. moisture.

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Table II show that the proportion of nitrogen present in the form of " true " protein was not decreased by the late applications of nitrogen fertilizers. Neither were the amounts of ammonia, amide and nitrate affected to any appreciable extent.

TABLE II

Treatments	When Applied (Days before Cutting)	N Applied (lb. per acre)	N Fractions as Percentage of Total N			
			True Protein	Ammonia	Amide	Nitrate
Sulphate of ammonia	10	17.4 34.7	85 86	0.9 1.4	4.1 3.5	0.3 0.1
	20	17.4 34.7	85 87	1.2 1.2	5.1 4.8	0.3 0
Nitrate of soda ..	10	17.4 34.7	86 86	1.0 0.9	4.3 4.0	0.3 1.0
	20	17.4 34.7	89 85	0.9 0.7	4.4 4.3	N.D. 0.4
Nitrochalk	10	17.4 34.7	87 86	0.9 1.2	5.4 4.9	0.9 0.5
	20	17.4 34.7	87 87	1.1 0.9	5.5 4.7	0.2 N.D.
No nitrogen	—	Nil	88	1.0	4.4	0.3

N.D. = not determined.

Aftermath. From the summary given in Table III for the aftermath, which was cut on October 30, it will be seen that the yield of dry matter was significantly increased by the double dressing of nitrogen. No other difference was significant.

TABLE III.—AFTERMATH

Nitrogen Applied (lb./acre)	Dry Matter (cwt./acre)	Crude Protein (percentage)	Crude Protein (cwt./acre)
0	9.74	14.75	1.44
17.4	9.84	15.50	1.54
34.7	11.80	14.99	1.64
Significant Difference (P = 0.05)	0.76	2.01	0.27

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Recovery in Hay and Aftermath of Nitrogen Applied. The percentage recoveries of added nitrogen were as follows:—

<i>Nitrogen Applied</i> (lb./acre)		<i>Percentage Recovery of Nitrogen</i>		<i>Total</i>
		<i>In Hay</i>	<i>In Aftermath</i>	
17.4	..	37	10	47
34.7	..	43	10	53

These figures are very satisfactory, and are quite as high as when nitrogen is applied early to increase yields.

Discussion. The figures demonstrate clearly that applying nitrogen fertilizers to hay ten to twenty days before harvest resulted in marked increases in protein content of the crop, and that the nitrogen absorbed by the crop was converted into "true" protein. This effect of nitrogen fertilizers may be doubly valuable since there is a distinct tendency for protein digestibility to increase with increase in crude protein content.¹

A point of some practical importance is whether the hay crop would be badly damaged by the passage of a horse and fertilizer drill at such an advanced stage of growth. We have as yet no experience on this point, but Sprague and Hawkins,⁴ who used a drill and team of horses in most of their experiments, report that "... little or no injury to the hay crop occurred if the plants were fully dry. Afternoon operation of the equipment is preferable to morning operation, since the plants are less turgid and brittle and readily resume an upright position after passage of the outfit."

In addition to improving the quality of hay, late dressings of nitrogen may be of considerable value in the production of dried grass and silage. It is particularly interesting in the case of grass drying, since it might result in the elimination of low-quality dried grass or "super"-hay.

It might also be a means towards lowering production costs of dried grass, since the crop might be cut at a more advanced stage of growth and thus give a greater yield of dry matter per acre, without any drop in quality.

Summary and Conclusions. Attention is called to the very low average protein content of the hay crop of this country.

The results of a field experiment show that nitrogenous fertilizers, if applied ten to twenty days before harvest, caused marked increases in the protein content of grass intended for hay. Despite rather dry weather, about 40 per cent. of the nitrogen applied was absorbed by the crop and converted into

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"true" protein. The remaining nitrogen increased the yield of aftermath.

It is pointed out that in addition to improving the quality of hay, late applications of nitrogenous fertilizers may be of considerable importance in the production of dried grass and silage.

The results of this preliminary experiment are reported in the hope that other workers may try the effect of late applications of nitrogen to hay on a practical scale, and determine at the same time what damage, if any, is caused by the passage of a fertilizer drill and horse over the crop at such an advanced stage of growth.

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The Paris Agricultural Machinery Exhibition

To the English visitor the *Salon de la Machine Agricole*, held in Paris during the latter half of February, offered the usual bewildering variety of machines familiar and unfamiliar; but, leaving aside the many devices concerned with vineyard cultivation and other special branches of Continental farming, the exhibition contained very little that was really new. Tractor exhibits included models by all the leading American manufacturers as well as quite a number of French and German machines, and covered a much wider range of sizes than one would ordinarily see at a British Show. There were, for example, several tracklaying machines of 60 drawbar horsepower and over, although the impression, formed during earlier visits to the *Salon*, that these monster machines are intended mainly for purposes outside everyday agriculture, was confirmed by the fact that apart from one or two heavy balance ploughs there were no large-scale implements to match. At the other end of the scale were tractors smaller even than the new American "baby" machines that are now being introduced here. Diesel engines were more numerous than ever, and more than one firm exhibited replacement units for fitting to tractors originally designed for petrol or paraffin. This, of course, is a direct reflection of the fact that, on the Continent, tractor paraffin is more expensive and of poorer quality than it is here. There were also two or three producer-gas conversion sets for operating tractors on wood-charcoal; one of them, fitted to a row-crop machine, looked hardly practical since its various components would interfere seriously with the driver's view of his work. Quite a large proportion of the wheel tractors, including some of the most powerful models, were on pneumatic tyres; while several firms also showed auxiliary strake devices for improving adhesion under difficult conditions.

Another feature of this part of the Exhibition was an

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extraordinarily wide range of two-wheeled market-garden cultivators. Indeed, it was curious to see among these two-wheeled machines some which, to all appearances, were more powerful than the smallest of the conventional type tractors; and one wondered just how big a man would be needed to control them for any length of time in the field. Some of the lighter machines, on the other hand, were so very small that they looked as if they would decrease, rather than increase, the output of an average labourer.

Tractor implements on the whole were disappointing, probably because Continental farmers have as yet no conception of anything like a completely horse-less farm. There was, for example, very little tractor row-crop equipment worthy of mention, although there were several wide and very up-to-date horse hoes. It is true that some American firms showed completely equipped row-crop tractors, including a very neatly arranged outfit on one of the new baby machines; but these attracted little interest, and seemed to have no more relation to Continental agriculture than similar outfits exhibited in this country have to our own farming. Among other exhibits in this section were two wide self-contained motor hoes. One of these was a four-wheeled outfit steered through a fore-carriage, and the other a three-wheel outfit steered from behind in the same way as a horse hoe. With both, the steersman would have to walk, so that the outfit conflicted with the general tendency with power-driven appliances in this country in two ways: in not providing a seat for the operator as the very first essential; and in being a special-purpose outfit not adaptable to any other use on the farm. One implement connected with row-crops is worthy of special notice, if only because it attracted more attention from visitors than anything else in the Show. This was a selection hoe which made use of a photo-electric cell—or, as it was more graphically described in the advertisements, a “photographic eye”—to replace the eye and discrimination of a manual worker. In principle this implement is a three-row rotary hoe, the tines of which fold up automatically when the beam of light operating the photo-electric cell is interrupted by a plant. In this side of its work it can be compared with the hand-operated gapping hoe, which at least one market gardener uses in this country, and which goes down a row of spaced plants cutting all the land except when it is opened out by the operator to miss the plants themselves. In the French

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machine the hoeing is done by rotary tines working across the row; while the "photographic eye" replaces the discrimination of the operator. Another use to which, in theory at any rate, the machine can be put is still more ingenious: namely to "gap" a drilled plant. In this case the photo-electric principle is set so as to operate intermittently at pre-determined intervals. The device then goes along the rows, say, cutting out 10 in. and leaving 3 in. of "plant" alternately, just like any of the many root thinners that have been invented from time to time, but with one important difference. This is, that if when the time comes for the tines to collapse and leave some plants standing, there are (due to faulty germination or some similar cause) no plants to leave, then the photographic eye takes charge and makes the outfit wait until the next batch of useful plants is reached. If the machine can do all this it will have achieved something very far-reaching; although two essentials to success may be mentioned. First, the seedbed will need more careful preparation than it ordinarily gets in this country—or the machine will mistake clods for plants; while, for sugar-beet at any rate, singling will need to be left to a later stage of plant development than is usual on the Continent. The only other sugar-beet implements worth mentioning were a grab-type loading device capable of loading 500-800 tons of roots per hour from a clamp; and the latest model of the Marliere beet toppler and lifter. The latter machine was tried out in this country some years ago, and, but for its habit of falling to pieces at intervals, was quite promising. Since that time manufacture has been taken over by a larger firm and, if the literature and testimonials offered by the makers are to be believed, the machine has been much improved.

Haymaking implements included several which aimed in one way or another at improving quality. Among these were a tedder of the kicker type with individual groups of tines working alternately to right and left so as to imitate hand tedding more exactly, and two "cocking" machines. Both of the latter were similar in principle to the "Javelotteur" exhibited among the new implements last year: that is, they first bunch the hay with a set of rake tines and then roll it into tubular bundles with a trailing canvas. In this form the hay is said to be extremely weatherproof and easy to handle subsequently. With the machine one man and a horse can bundle about an acre an hour. Another firm exhibited hay

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tripods provided with spike-like projections which are said both to make it easier to build a weatherproof cock and to prevent over-consolidation.

Field baling also seems to be making progress on the Continent and the equipment on view included several balers rather different from any that have yet appeared here. One American pick-up baler was provided with its own engine, a feature which many users of power take-off outfits have felt would be an improvement. Another machine of the same kind had its pick-up straight ahead of the baler so that the usual cross-elevator was eliminated. Of the many self-tying press balers, several were clearly being developed in the direction of a tighter and neater bale, with a packing mechanism of the piston type. All the larger stationary balers had built-in elevators so that the machines could be fed from ground level. This is typical of the French point of view, which generally appears to aim at saving labour in and around the barnyard. Nearly every French threshing machine, for example, has a self-feed attachment, while forage hoists and conveyors are always prominent.

On this occasion several pneumatic conveyors for hay or straw were exhibited but, from the point of view of our farming, these would appear to be of rather limited application.

Combine harvesters have never been very prominent at the *Salon* but at least two new ones were on view this year. One of these was the miniature 40-in. machine which has been introduced to interest the American 4-horse farmer and which will probably be tried in this country during the coming harvest. The other new combine was the latest model of the Claas machine, earlier models of which were tried out here a year or two ago. It is a power take-off machine with a 6 ft. cut and it adds to the usual accomplishments of a combine the very useful one of binding the straw into sheaves.

Among the many other general exhibits there may be noted a new flax pulling machine; the Tubator drainage machine; several devices for overhead irrigation; and a vast pneumatic-tyred manure distributor some 30 ft. wide, intended for use in Africa. The latter had a built-in run-way for moving manures from one end to the other during filling. The Tubator is the German machine which draws a mole drain and lines it with a continuous and porous concrete pipe which it makes *in situ*. It attracted a good deal of attention and, it is understood, has been left in France to undertake contract work.

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The Storage of Eggs

In the U.S.A. the cold storage of eggs is an important industry, approximately 15 per cent. of the total production (equivalent to about 3,000 million) being stored in commercial warehouses. The eggs are placed in store during March, April, May and June when production is large and eggs are cheap, and withdrawal begins in August, increasing gradually until the middle of November when the price has risen; very few eggs are carried over to January. Large quantities are stored for one to two months only, and then released on a rising market.

In this country, on the other hand, few of the 3,350 odd million eggs produced annually are stored either by housewives or in commercial stores. The number of inquiries addressed to the Food Investigation organization of the Department of Scientific and Industrial Research has shown, however, that there is a considerable interest in the subject. The Department has accordingly issued a short leaflet* on the principles and relative merits of the methods used. Those dealt with are cold storage in air alone, partial "gas-storage," that is, cold storage with the addition of 2-2½ per cent. of carbon dioxide in the atmosphere of the store, and full "gas-storage," involving cold storage in an atmosphere containing 60 per cent. of carbon dioxide. In the first two methods the humidity of the atmosphere in the store is controlled, but not in the third.

Precautions are necessary in selecting and handling eggs for storage. The eggs selected should be of the highest quality and infertile. They should be cooled and stored as soon as possible after laying. Eggs laid in March or April store better than those laid in the warmer months. On no account should the eggs be washed. Any method of washing increases, it is stated, the number of "rots" and particularly the "green rots" which ultimately give an unpleasant cabbage-water smell to the eggs. Stored eggs should be de-chilled artificially and should always be candled and repacked before distribution.

It is not recommended that eggs should be stored by any of

* Food Investigation Leaflet No. 8. *The Cold Storage and Gas Storage of Eggs*. Copies may be obtained gratis on application to the Secretary, Department of Scientific and Industrial Research, 16 Old Queen Street, Westminster, S.W.1.

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the methods described for periods in excess of nine months. Cold storage gives satisfactory results for periods up to about five months. When eggs are cold-stored for longer periods, a certain proportion develop "storage-taste." For this reason one of the methods of gas-storage may be preferred. The air-cell enlarges as storage proceeds; this is important, since the size of the air-cell is a recognized commercial index of quality. A large air-cell also tends to spoil the appearance and texture of an egg when it is boiled.

A concentration of one part in a million of ozone, it is observed, slightly delays the appearance of storage taste in the yolk. Too high concentrations (e.g., 5 parts in a million) tend to give a metallic or "cucumber" taste to the yolk.

Partial gas storage has definite advantages over cold storage, notably in preventing the development of "storage-taste." As with cold storage, the air-cell enlarges.

In full gas-storage, the white becomes very watery, a serious disadvantage when the eggs are fried or poached in water. On the other hand, the method keeps the air-cell small, and is the most effective of the three in preventing rots; it cannot, however, prevent rots developing during marketing, since, for example, it does not always destroy the micro-organisms causing green whites, though it stops them growing in storage. There is no evidence that the method tends to produce sunk or stuck yolks. The equipment necessary for full gas-storage is described in some detail.

Heathfield Poultry Packing Station

Probably very few of our native industries can rival the long tradition that is attached to the rearing and fattening of table poultry in Sussex. Records of the fifteenth century provide evidence of a flourishing industry and of the methods then employed, which differed little from those in use at the present time, except that machine cramming has superseded the hand method.

Heathfield has long been the centre of this industry and its latest activity—the erection of a new poultry packing station—is a sign that this town is in no danger of ceding its premier position. The new packing station, which was opened by the Minister of Agriculture on March 7, is the most up-to-date one

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in the country, and the first to be built for the express purpose of processing and marketing chicken.

The building, which was erected at a cost of £1,800, is attractively designed and well adapted to its purpose. It comprises three floors, with garage, transport sheds, store room, feather room and offices. The birds are dealt with first on the middle floor, which is devoted to plucking and stubbing, and access to which is from a raised platform where arrivals are unloaded. Here a throughput of about 1,000 chicken can be dealt with daily. After the plucking and stubbing process, the feet of the birds are washed in special sinks before the birds are sent below on a slide conveyor to the cooling room. This room, on the lower ground floor, has been partly excavated below ground and is extremely well designed for maintaining a low temperature to keep the poultry in first-class condition. The walls are lined with tiers of shaping troughs, and the central space is occupied by a large table, on which the birds are graded, packed, and labelled with the "Heffle" brand with which is incorporated the National Mark. The top floor is devoted to box making.

This station has been built for the Heathfield and South-Eastern Poultry (Co-operative) Society, Ltd., which was formed in 1934 as an association of several other societies in the district. In the same year, the Society received authorization under the National Mark Poultry Scheme. Its progress has been steady during the last four years, the total throughput of birds rising from 63,000 in 1935 to 149,000 in 1938. The proportion of the throughput, however, which has, up to the present, been packed under the National Mark, has been low. The Society is now handling some 4,000 head of poultry weekly and had outgrown its former premises. With the new building and the up-to-date equipment it will be possible to deal with greatly increased quantities.

The members' supplies are graded and handled on a service basis. They are, therefore, assured of receiving returns in accordance with market value and at the lowest possible cost for marketing. Unfortunately, a considerable proportion of the supplies is delivered in an unfinished condition, and the producers in these instances lose the extra profit which can be obtained by the Society for properly finished birds. This has been one of the reasons why a larger proportion of the output has not been put under the National Mark. The general quality of the supplies is, however, showing marked

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improvement and the high standards adopted in the preparation and packing of the poultry—which reflect great credit on the management and staff—can be expected to bring increased success and expansion of the work of the Society.

In his speech the Minister said that the new station represented a great lesson in co-operation. Farmers were very practical people, and if they could see that co-operation was the means of reaching their end they would co-operate. He hoped that the success of the Heathfield enterprise would encourage more people to join in and so make the best use of the assistance offered by the Ministry through the National Mark Scheme. Producers have to gain the confidence of the consumers, and he wanted the industry to help him in his job by seeing that the public could have real confidence in the standards they were trying to set.

Post-Graduate Agricultural Scholarships and Refresher Course Grants

The Ministry of Agriculture and Fisheries and the Department of Agriculture for Scotland invite applications for (i) agricultural scholarships from students who propose to follow the career of Agricultural Organizer or Instructor or Lecturer in Agriculture (including horticulture, dairying and poultry husbandry), and (ii) grants for refresher courses for Agricultural Organizers, Instructors and Lecturers already employed on the staffs of County Agricultural Educational Authorities in England and Wales and from County Organizers and Instructresses on the staffs of Agricultural Colleges in Scotland. The selection from candidates will be by interview, and the allocation of the scholarships and grants between the applicants from England, Wales and Scotland will be made entirely on the basis of merit.

AGRICULTURAL SCHOLARSHIPS. The object of the scholarships, of which not more than 5 will be awarded in 1939, is to broaden the agricultural knowledge and experience of students and so to qualify them for the position of agricultural organizer, instructor, or lecturer.

Candidates must be British born. They should be graduates of a University, but exceptional candidates, otherwise qualified, who have not had the opportunity of graduating,

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will be regarded as eligible. Application may also be made in respect of candidates who have sat for a Degree or Diploma examination of which the result has not been announced. In addition, candidates should have had some experience of practical farming. Candidates must be nominated by a Professor, Principal or Lecturer of a University or College on the prescribed form.

The value of the scholarships will not exceed £200 together with an allowance for approved fees and travelling expenses. The amount may be varied in accordance with the scholar's means and may cover the whole of the cost of training, including maintenance, or a proportion only of such cost.

The period of the scholarships is normally one year and commences on October 1. It will be spent at such agricultural educational or research institutions, advisory centres or farms as the Ministry or the Department may direct.

REFRESHER COURSE GRANTS. The purpose of the refresher course grants is to provide means and opportunity for those already engaged in agricultural educational work to widen their knowledge of particular branches of agriculture and to become acquainted with recent advances on the scientific side of the subject. Applications for grants for this purpose must be made on the prescribed form to the Ministry or the Department, and must be approved by the Authority or the governing body of the College by whom the applicant is employed and by whom the salary of the applicant would be payable during the period of the course.

The period of a course will normally be about 4 weeks, and in any instance will not exceed 8 weeks, and will be spent at such agricultural educational or research institutions, advisory centres or farms as the Ministry or the Department may approve. Reasonable travelling and subsistence expenses and any fees incurred by a successful applicant in taking a course will be defrayed.

Forms of application for both the agricultural scholarships and the refresher course grants and all other particulars may be obtained by English and Welsh applicants from the Secretary, Ministry of Agriculture and Fisheries, 10, Whitehall Place, London, S.W.1, and by Scottish applicants from the Secretary, Department of Agriculture for Scotland, 29, St. Andrew Square, Edinburgh, 2. The latest date for receiving applications is June 1, 1939.

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Marketing Notes

Wheat (Amendment) Bill, 1939. A Bill to amend the Wheat Act, 1932, was introduced by the Minister into the House of Commons on February 28. The Bill provides, *inter alia*, (a) for the appointment in 1939, and in each third succeeding year, of a Committee to report to the Minister as to the desirability of altering the "standard price" of 45s. per quarter laid down in the Act; (b) for a new method, based upon ash content, for distinguishing between "flour" and "wheat offals," and for a reduced scale of quota payments in respect of low-grade flour destined for live stock; and (c) for the total exemption from quota payments of wheat meal and other wheaten products, produced in the United Kingdom and destined for live stock, provided they are mixed with an equal quantity (in some cases less) of any non-wheaten feeding stuff, whether used in the form of meal, or manufactured into cubes or pellets.

National Mark Dressed Poultry Scheme. The aggregate output of the authorized packing stations during 1938 was 1,413,000 birds, of which 516,000 (including turkeys and geese that were disposed of under the special arrangement for grading and marking these birds at Christmas) were packed under National Mark labels.

The National Mark output for last year was the highest recorded for any year since the inauguration of the National Mark Dressed Poultry Scheme in 1930, and represented an increase of 25 per cent. over the previous year's National Mark output of 412,000 birds.

National Mark Publicity.—Arrangements have been made and preparations are well in hand in connexion with a special exhibition which will be staged by the Ministry at Charing Cross Underground Station from May 31 to June 23.

PROGRESS OF THE LAND FERTILITY SCHEME

The number of applications for contribution under the Land Fertility Scheme received from occupiers of agricultural land in the United Kingdom now exceeds 366,000. The quantities of lime and basic slag in respect of which these applications have been made are approximately 2,608,000 tons of lime and 711,000 tons of basic slag.

The Scheme came into operation on September 6, 1937. During the period September 6, 1937, to March 2, 1938, 123,000 applications for contribution were received in respect of 756,000 tons of lime and 296,000 tons of basic slag. In the corresponding period (September 4, 1938, to March 11, 1939) this season 119,000 applications have been received in respect of 949,000 tons of lime and 247,000 tons of basic slag.

PRICES OF ARTIFICIAL MANURES

Description.	Average prices per ton (2,240 lb.) during week ended March 15				
	Bristol	Hull	L'pool	London	Costs per Unit¶
Nitrate of Soda (N. 15½%) ..	£ 8 0c	£ 8 0c	£ 8 0c	£ 8 0c	s. d. 10 4
" " Granulated (N. 16%) ..	8 0c	8 0c	8 0c	8 0c	10 0
Nitrate of Lime (N. 13%) ..	7 7e	7 7e	7 7e	7 7e	11 4
Nitro-Chalk (N. 15½%) ..	7 10c	7 10c	7 10c	7 10c	9 9
Sulphate of Ammonia :—					
Neutral (N. 20.6%) ..	7 14c	7 14c	7 14c	7 14c	7 6
Calcium Cyanamide (N. 20.6%) ..	7 17d	7 17d	7 17d	7 17d	7 8
Kainite (Pot. 14%) ..	2 18	2 15	2 15	2 15	3 11
Potash Salts (Pot. 30%) ..	5 4	5 1	5 0	5 1	3 5
" " (Pot. 20%) ..	3 15	3 12	3 12	3 12	3 7
Muriate of Potash (Pot. 50%) ..	8 10	8 8	8 5	8 8	3 4
Sulphate " (Pot. 48%) ..	10 2	10 0	9 17	10 0	4 2
Basic Slag (P.A. 15½%) ..	2 12b	2 5b	—	2 10b	3 2
" (P.A. 14%) ..	2 8b	2 0b	2 0b	2 6b	3 3
Grd. Rock Phosphate (P.A. 20-27½%) ..	3 5a	3 0a	2 15a	2 10a	1 10
Superphosphate (S.P.A. 16%) ..	3 6k	—	3 2f	2 19g	3 9
" (S.P.A. 13½%) ..	—	—	2 19f	2 16g	4 1
Bone Meal (N. 3½%, P.A. 20½%) ..	—	7 5	6 17h	6 12	—
Steamed Bone Flour (N ½%, P.A. 27½-29½%) ..	—	4 15	4 15h	4 10	—

Abbreviations : N. = Nitrogen : P.A. = Phosphoric Acid :
S.P.A. = Soluble Phosphoric Acid : Pot. = Potash.

* Prices are for not less than 6-ton lots at purchaser's nearest railway station, unless otherwise stated. Unit values are calculated on carriage-paid prices.

§ Prices are for not less than 2-ton lots, nett cash for prompt delivery, f.o.r., in town named, unless otherwise stated. Unit values are calculated on f.o.r. prices.

a Prices for 4-ton lots f.o.r. Fineness 85% through standard sieve.

b Prices for 6-ton lots. Prices at Bristol are f.o.r. Bridgwater; at Hull and Liverpool f.o.r. neighbouring works and at London f.o.r. at depots in London districts. Fineness 80% through standard sieve.

c For lots of 4 tons and under 6 tons the price is 1s. per ton extra, for lots of 2 tons and under 4 tons 5s. per ton extra, for lots of 1 ton and under 2 tons 10s. extra, and for lots of 2 cwt. and under 1 ton, 20s. extra.

d Delivered in 5-ton lots at purchaser's nearest railway station. For lots of 2 tons and under 5 tons the price is 5s. per ton extra, for lots of 1 ton and under 2 tons, 10s. per ton extra, and for lots of 4 cwt. and under 1 ton, 20s. extra.

e For lots of 4 tons and under 6 tons the price is 1s. per ton extra, for lots of 2 tons and under 4 tons 5s. per ton extra, for lots of 1 ton and under 2 tons 7s. 6d. per ton extra, and for lots of under 1 ton, 20s. extra.

f Prices shown are f.o.r. Widnes.

g Prices shown are ex works London, f.o.r. southern rails, 1s. 3d. extra.

h Prices shown are f.o.r. Appley Bridge.

k Price shown is f.o.r. Avonmouth.

¶ These are calculated by regarding a ton as comprising 100 "units" (equal parts of 22.4 lb.), so that a fertilizer, for example, with 16 per cent. nitrogen contains 16 such "units" in a ton. Then, if the price per ton of such a fertilizer be divided by the percentage figure, the deduced cost is that of a "unit" of that agent. Those in the table above are based on London prices. (For further explanation, see Advisory Leaflet, No. 146, "The Valuation of Artificial Manures," obtainable from the Ministry, free of charge.)

PRICES OF FEEDING STUFFS

Description	Price per ton	Manu- rial value per ton	Cost of food value per ton	Starch equiv. per 100 lb.	Price per unit starch equiv.	Price per lb. starch equiv.	Pro- tein equiv.
Wheat, British ..	£ s. 4 0	£ s. 0 9	£ s. 3 11	72	s. d. 1 0	d. 0.54	% 9.6
Barley, British Feeding ..	6 0	0 9	5 11	71	1 7	0.85	6.2
" Canadian No. 3 ..							
Western ..	6 3	0 9	5 14	71	1 7	0.85	6.2
Dutch ..	5 15½	0 9	5 6	71	1 6	0.80	6.2
Persian ..	5 13*	0 9	5 4	71	1 6	0.80	6.2
Russian ..	6 7	0 9	5 18	71	1 8	0.89	6.2
Oats, English, white ..	6 0	0 9	5 11	60	1 10	0.98	7.6
" " black and grey ..	6 0	0 9	5 11	60	1 10	0.98	7.6
" Scotch, white ..	6 17	0 9	6 8	60	2 2	1.16	7.6
" Canadian—							
No. 2 Western ..	6 10*	0 9	6 1	60	2 0	1.07	7.6
No. 3 Western ..	5 18½	0 9	5 9	60	1 10	0.98	7.6
Mixed feed ..	5 12	0 9	5 3	60	1 9	0.94	7.6
No. 1 feed ..	6 8†	0 9	5 19	60	2 0	1.07	7.6
No. 2 feed ..	6 5	0 9	5 16	60	1 11	1.03	7.6
Maize, American ..	6 10	0 7	6 3	78	1 7	0.85	7.6
" Argentine ..	6 12	0 7	6 5	78	1 7	0.85	7.6
" Danubian ..	6 2†	0 7	5 15	78	1 6	0.80	7.6
" Russian ..	6 2†	0 7	5 15	78	1 6	0.80	7.6
" South African							
No. 2 white flat ..	6 17†	0 7	6 10	78	1 8	0.89	7.6
Benguela ..	6 2†	0 7	5 15	78	1 6	0.80	7.6
Beans, English, Winter ..	6 0½	0 18	5 2	66	1 7	0.85	19.7
Peas, English, blue ..	8 15½	0 15	8 0	69	2 4	1.25	18.1
" Japanese ..	19 15†	0 15	19 0	69	5 6	2.95	18.1
" Russian ..	6 5†	0 15	5 10	69	1 7	0.85	18.1
Dari ..	8 0†	0 8	7 12	74	2 1	1.12	7.2
Milling Offals:—							
Bran, British ..	6 2	0 17	5 5	43	2 5	1.29	9.9
Broad ..	6 15	0 17	5 18	43	2 9	1.47	10.0
Middlings, fine,							
imported ..	5 5	0 14	4 11	69	1 4	0.71	12.1
Weatings† ..	5 5	0 15	4 10	56	1 7	0.85	10.7
" Superfine† ..	5 12	0 14	4 18	69	1 5	0.76	12.1
Pollards, imported ..	5 2	0 15	4 7	50	1 9	0.94	11.0
Meal, barley ..	7 2	0 9	6 13	71	1 10	0.98	6.2
" grade II ..	6 10	0 9	6 1	71	1 8	0.89	6.2
maize ..	6 15	0 7	6 8	78	1 8	0.89	7.6
" germ ..	6 17	0 11	6 6	84	1 6	0.80	10.3
locust bean ..	7 5	0 6	6 19	71	1 11	1.03	3.6
bean ..	9 7	0 18	8 9	66	2 7	1.38	19.7
white fish ..	15 17	2 5	13 12	59	4 7	2.46	53.0
Soya bean (extracted)† ..	8 12	1 11	7 1	64	2 2	1.16	38.3
Maize, cooked, flaked ..	7 10	0 7	7 3	84	1 8	0.89	9.2
" gluten feed ..	6 12	0 13	5 19	76	1 7	0.85	19.2

PRICES OF FEEDING STUFFS (continued)

Description	Price per ton	Manu- rial value per ton	Cost of food value per ton	Starch equiv. per 100 lb.	Price per unit starch equiv.	Price per lb. starch equiv.	Pro- tein equiv.
	£ s.	£ s.	£ s.		s. d.	d.	%
Linseed cake—							
English, 12% oil ..	9 17	1 1	8 16	74	2 5	1·29	24·6
„ 9% „ ..	9 5	1 1	8 4	74	2 3	1·21	24·6
„ 8% „ ..	9 0	1 1	7 19	74	2 2	1·16	24·6
Cottonseed cake,							
English, Egyptian							
seed, 4½% oil ..	6 0	0 19	5 1	42	2 5	1·29	17·3
Cottonseed cake,							
Egyptian, 4½% oil ..	5 7	0 19	4 8	42	2 1	1·12	17·3
Cottonseed cake,							
decorticated, 7-8% oil	7 12†	1 10	6 2	68	1 10	0·98	34·7
Cottonseed meal,							
decorticated, 7-8% oil	8 5†	1 10	6 15	70	1 11	1·03	36·8
Coconut cake, 5-6% oil	7 7	0 19	6 8	77	1 8	0·89	16·4
Ground nut cake,							
6% oil ..	6 15*	0 19	5 16	57	2 0	1·07	27·3
Ground nut cake,							
imported decorticated,							
6-7% oil ..	7 2	1 9	5 13	73	1 7	0·85	41·3
Palm-kernel cake,							
5½% oil ..	7 2†	0 13	6 9	73	1 9	0·94	16·9
Palm-kernel cake meal,							
5½% oil ..	7 5†	0 13	6 12	73	1 10	0·98	16·9
Palm-kernel meal,							
1-2% oil ..	6 15	0 13	6 2	71	1 9	0·94	16·5
Feeding treacle ..	5 0	0 8	4 12	51	1 10	0·98	2·7
Brewers' grains, dried ale	5 17	0 11	5 6	48	2 2	1·16	12·5
Brewers' grains, dried							
porter ..	5 10	0 11	4 19	48	2 1	1·12	12·5

* At Bristol.

§ At Hull.

† At Liverpool.

‡ In these instances manurial value, starch equivalent and protein equivalent are provisional.

NOTE: The prices quoted above represent the average prices at which actual wholesale transactions have taken place in London, unless otherwise stated, and refer to the price ex mill or store. The prices were current at the end of February, 1939, and are, as a rule, considerably lower than the prices at local country markets, the difference being due to carriage and dealers' commission. Buyers can, however, easily compare the relative values of the feeding stuffs on offer at their local market by the method of calculation used in these notes. Thus, if linseed cake is offered locally at £11 per ton, then since its manurial value is £1 1s. per ton as shown above, the cost of food value per ton is £9 19s. Dividing this figure by 74, the starch equivalent of linseed cake as given in the table, the cost per unit of starch equivalent is 2s. 8d. Dividing this again by 22·4, the number of pounds of starch equivalent in one unit, the cost per lb. of starch equivalent is 1·43d. Similar calculations will show the relative cost per lb. of starch equivalent of other feeding stuffs on the same local market. From the results of such calculations a buyer can determine which feeding stuff gives him the best value at the prices quoted on his own markets. The figures given in the table under the heading "manurial value per ton" are calculated on the basis of the following unit prices:—N., 7s. 7d.; P₂O₅, 2s. 6d.; K₂O, 3s. 8d.

FARM VALUES OF FEEDING STUFFS

The prices in respect of the feeding stuffs used as bases of comparison for the purpose of this month's calculations are as follow :—

	Starch equivalent Per cent.	Protein equivalent Per cent.	Per ton £ s.
Barley (imported)	71	6.2	5 19
Maize	78	7.6	6 12
Decorticated ground-nut cake ..	73	41.3	7 2
„ cotton-seed cake ..	68	34.7	7 12

(Add 10s. per ton, in each instance, for carriage.)

The Table below is issued as a guide to farmers respecting the feeding value of their crops in relation to current market prices. (The "food values," which it is recommended should be applied by Agricultural Organizers and other advisers in connexion with advisory schemes on the rationing of dairy cows, are given in the December, 1938, issue of the Ministry's Journal, p. 965.)

FARM VALUES

Crop	Starch equivalent Per cent.	Protein equivalent Per cent.	Food value per ton, on farm £ s.
Wheat	72	9.6	6 13
Oats	60	7.6	5 11
Barley	71	6.2	6 8
Potatoes	18	0.8	1 12
Swedes	7	0.7	0 13
Mangolds	7	0.4	0 12
Beans	66	19.7	6 12
Good meadow hay	37	4.6	3 8
Good oat straw	20	0.9	1 15
Good clover hay	38	7.0	3 12
Vetch and oat silage	13	1.6	1 4
Barley straw	23	0.7	2 0
Wheat straw	13	0.1	1 3
Bean straw	23	1.7	2 1

RECENT OFFICIAL PUBLICATIONS

The Ministry's Advisory Publications. Since the date of the list published in the January, 1939, issue of this JOURNAL (p. 1071), the under-mentioned Advisory Publications have been issued by the Ministry.

BULLETINS :

No. 2.—Fruit Production: Tree Fruits (4th Edition). 2s. 6d. (2s. 9d. post free).

The latest methods of production are now dealt with in this considerably amplified edition.

No. 20.—Some Beneficial Insects (4th Edition). 9d. (10d. post free).

Entirely re-written by the Director of the Farnham House Laboratory of the Imperial Institute of Entomology (see p. 1267 of last month's issue for further information).

RECENT OFFICIAL PUBLICATIONS

No. 62.—Commercial Bulb Production (2nd Edition). 1s. 6d. (1s. 8d. post free).

Substantially revised. Brings together the results of much experimental work carried out by the growers in Lincolnshire and at the Kirton Experimental Station during the past five years.

No. 78.—A Selected and Classified List of Books on Agriculture (2nd Edition). 6d. (7d. post free).

The large number of books on agriculture published in recent years necessitates this 2nd Edition.

Copies of the above are obtainable at the prices mentioned from the Sales Offices of H.M. Stationery Office or through any bookseller.

ADVISORY LEAFLETS :

No. 109.—Flea Beetles. (Revised.)

No. 130.—Carnations. (Revised.)

No. 184.—Faults and Difficulties in Buttermaking. (Revised.)

No. 185.—Table Poultry Production. (Revised.)

No. 270.—Soil Analysis. (Revised.)

No. 296.—Verticillium Wilt and Black Dot Disease of the Potato. (New.)

Copies of any of the above-mentioned leaflets may be purchased from H.M. Stationery Office, York House, Kingsway, London, W.C.2, or at the Sale Offices of that Department at Edinburgh, Manchester, Cardiff, and Belfast, price 1d. each net (1½d. post free), or 9d. net per doz. (10d. post free).

Single copies of not more than 20 leaflets may, however, be obtained, free of charge, on application to the Ministry. Further copies beyond this limit must be purchased from H.M. Stationery Office, as above.

A list of the Ministry's publications, including bulletins and leaflets on agriculture and horticulture, may be obtained free and post free on application to the Ministry.

FARM WORKERS' MINIMUM RATES OF WAGES

Agricultural Wages Board.—At a meeting held on February 27, 1939. Orders were made continuing the minimum rates of wages unchanged in the following areas : Berkshire (33s. 6d.), Cambridgeshire and Isle of Ely (35s.), Devonshire (35s. 6d.), Gloucestershire (34s.), Hampshire and Isle of Wight (33s.), Lincolnshire (Kesteven and Lindsey) (34s. 6d.), Middlesex (38s. 6½d. in summer and 37s. in winter), Monmouth (35s.), Norfolk (34s. 6d.), Shropshire (35s.), Warwickshire (33s.) and Glamorganshire (36s.). (The figures quoted are the minimum weekly wages for adult ordinary male workers). The Orders also, except in the case of Monmouth, made directions with regard to holidays with pay, the number of days to be allowed as holidays for whole-time workers in regular employment being, in Shropshire, Warwickshire and Glamorganshire, 6 days; in Lincolnshire (Kesteven and Lindsey), 4 days, and in the remaining areas, 3 days. In all instances holiday remuneration is fixed at daily rates proportionate to the minimum rates. For full details of the minimum rates and holiday directions, and of the various provisions connected with them, reference should be made to the Orders, copies of which may be obtained free of charge from the Secretary, Ministry of Agriculture and Fisheries, Kings Buildings, Smith Square, London, S.W.1.

Enforcement of Minimum Rates of Wages.—During the month ending March 10, 1939, legal proceedings were taken against 3 employers for failure

FARM WORKERS' MINIMUM RATES OF WAGES

to pay the minimum rates of wages fixed by the Orders of the Agricultural Wages Board. Particulars of the cases follow :—

Committee Area	Court	Fines Imposed	Costs Allowed	Arrears of Wages Ordered	No. of workers involved
Carmarthen Lancs .. Shropshire	Carmarthen	£ s. d. 0 10 0	£ s. d. 0 15 0	£ s. d. 20 10 0	1
	Padiham ..	1 0 0	2 8 0	35 0 0	1
	Market Drayton.	1 0 0	0 10 0	50 0 0	1
	Totals ..	2 10 0	3 13 0	105 10 0	3

AGRICULTURAL INDEX NUMBER

MONTHLY INDEX NUMBERS OF PRICES OF AGRICULTURAL PRODUCE
(BASE, 1927-29=100.)

Uncorrected for
Seasonal Variation

Corrected for
Seasonal Variation

Month	1937	1938	1939	1937	1938	1939
January	90	97	90	85	90	84
February	91	95	88	86	89	82
March	90	88		90	88	
April	89	85		92	89	
May	82	82		88	90	
June	81	81		89	90	
July	82	86		88	91	
August	83	81		87	86	
September	87	81		89	83	
October	93	86		89	82	
November	99	89		92	82	
December	100	90		92	82	

THE SAME, TAKING ACCOUNT OF PAYMENTS UNDER THE WHEAT ACT (a),
THE CATTLE SUBSIDY (b), AND GOVERNMENT PAYMENTS FOR MILK (c)

Month	1947	1938	1939	1937	1938	1939
January	92	99	95*	86	93	89*
February	93	97	93*	88	92	88*
March	92	91		92	91	
April	90	88		93	92	
May	83	84		90	92	
June	82	83		89	92	
July	83	88		89	96	
August	85	84*		89	89*	
September	89	84*		91	86*	
October	95	91*		91	86*	
November	101	94*		94	86*	
December	102	94*		94	86*	

(a) Commenced August, 1932. (b) Commenced September, 1934.

(c) Commenced April, 1934. * Provisional.

APPOINTMENTS

Cambridgeshire: Mr. F. Shaw as Assistant Instructor in Horticulture.
West Suffolk: Mr. E. T. Sykes, M.A., as Organiser of Agricultural Education. **Yorkshire:** Mr. R. F. Martyr, B.Sc.(Hort.), as Instructor in Horticulture. **Denbighshire:** Miss M. Jones, B.Sc., N.D.D., As assistant Dairy Instructress.

WIRELESS TALKS, APRIL, 1939

<i>Station and Date</i>	<i>Time p.m.</i>	<i>Speaker</i>	<i>Subject</i>
NATIONAL :			
6	6.20	Mr. A. Hurd and others	Pig Marketing.
13	6.20	"	Potato Marketing.
20	6.20	"	Milk Marketing.
27	6.20	Mr. A. Hurd	Where does Farming stand to-day ?
MIDLAND :			
6	8.00	Messrs. C. Norbury and A. Haggard	Midland Farmers' Club : Should we grow more apples ?
11	6.15	—	Topical Talk.
18	8.10	Lord Astor, Messrs. J. H. Wain, C. Higgs, A. P. McDougal and C. Turner	Plan Production, or Perish : Does the prosperity of British farming depend as much on internal reorganization as on a change of official policy ?
WEST :			
4	8.25	Cornwall v. Somerset	Agricultural Bee : Final.
6	6.40	—	Young Farmers in the Spring.
13	6.40	Discussion between Messrs. T. Neale, R. Lawrence and A. W. Ling	Grassland Competition.
20	6.40	—	Calf Rearing.
27	6.40	—	Pigs out of Doors
NORTH :			
13	6.40	Messrs. W. B. Mercer and J. Strachan	North Country Farming.
7	6.40	Mr. J. Strachan and others	—

NOTICES OF BOOKS

Humus-- Origin, Chemical Composition and Importance in Nature. By Selman A. Waksman. Second Edition. Pp. xiv + 526. Illus. (London : Ballière, Tindall & Cox. 1938. Price 30s.)

The importance of humus in agriculture has always been recognized, but its chemical nature, formation and function in plant nutrition and soil processes has remained obscure.

In recent years, attention has been drawn to the deterioration of soils as a result of cultivation, or as a result of wind and water erosion, and to the important part that soil humus plays in the restoration and maintenance of fertility. The publication of this book is opportune and will be welcomed by research workers and students directly interested in the subject. There is much, however, which will also interest the general public of agriculturists.

The author provides in this treatise a complete study of humus in all its aspects, including its importance in soil processes, in plant nutrition and in industrial utilization ; supplemented by an appendix in which the analysis of humus and of certain humus constituents, that have found extensive use, are given and discussed, together with a most extensive bibliography.

NOTICES OF BOOKS

Theory and Practice in the Use of Fertilizers. By Firman E. Bear. 2nd edition. Pp. ix + 360. (New York: John Wiley & Sons; London: Chapman & Hall, 1938. Price 20s.)

Dr. Bear has produced an admirable volume, full of detail and of considerable interest both to the agricultural chemist and to the general student of agriculture. As he says in his opening paragraph, the art of agriculture dates from prehistoric times, but the science of agriculture is only some 300 years old, and that science has been based very largely on the conception that increased productivity can only be obtained by the judicious use of plant food, either as organic matter or as chemical salts. This book brings together in one volume a great deal of information and the views of some of the greatest authorities on the subject; for this reason it tends to be more historical in nature than the normal "technical" treatise, and Dr. Bear is to be congratulated on the excellent way in which he has set out his material and on the considerable research he has undertaken in its collation.

The first half of the book reviews the discoveries of the great chemists with regard to soil science and the use of fertilizers, and faithfully sets down their conclusions. There is an excellent chapter on the famous nitrogen controversy, ending in the experiments of Lawes and Gilbert at Rothamstead which proved the value of nitrogenous manures in the soil as a source of plant food. This is followed by a review of the processes of nitrogen-fixation both by legumes and non-legumes, and of nitrification, with a lucid exposition of the nitrogen economy in soils. The mineral theory follows and the use made by plants of phosphates, potash and other minerals are dealt with in the same way as for nitrogen. The more recent discoveries of the soil chemists that climate and not geological formation is the predominating factor in the formation of soils are set out in some detail and the work of the Russian scientists in this connexion is touched upon.

Turning from the theoretical side of his subject to the practical, Dr. Bear becomes more interesting to the lay reader and his review of the development of the fertilizer industry and of the uses of the "carriers" of nitrogen, phosphates and potash, can be read with benefit by the more enlightened farmer as well as by the student seeking information. A good deal is said about mixed fertilizers and their sale. In the U.S.A. for various reasons it is a much commoner practice than in Europe to buy mixed fertilizers, particularly for intensive cultivation, than to purchase the ingredients and mix on the farm. Such a practice is of course becoming more common in this country, but it has attained very large proportions in the U.S.A. with the attendant evils in the way of the inclusion of poor quality materials by unscrupulous manufacturers, and has led to elaborate formulas and "triangles" for the correct use of such mixtures in almost all conceivable circumstances.

Dr. Bear follows his description of the fertilizer industry with an exposition of the principles of the application of fertilizers, setting out in considerable detail the ideal mixtures and constituents for various conditions. Organic fertilizers and the making of artificial farmyard manure are also touched upon, and a new chapter has been added dealing with "trace" elements--those elements such as boron, iron, copper and magnesium, which, when present in small quantities, favourably influence the growth of plants, though if given in excess produce toxic effects. The book ends rather abruptly on this note.

There is a tendency on the part of American scientists to issue a mass of literature on their particular subjects which often confuses the reader on this side of the Atlantic; it is refreshing to have this information set out as Dr. Bear has done in a very readable form, and to be able to

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obtain a clear conception of American ideas and practices. The English reader may at first be a little irritated by American spelling, which often appears to lack consistency, but such irritation is soon forgotten and one reads of "sulfates" and "program" without offence.

Plant Growth Substances. By Hugh Nicol. Pp. xii + 106. Illus. (London: Leonard Hill. 1938.)

In this little book Mr. Nicol has succeeded in presenting a very interesting introduction to the study of plant growth substances, which have been attracting so much attention during the past few years. The book, however, is hardly for the layman if he lacks a sound chemical background. It contains a detailed discussion of the chemistry of the natural hormones and of the synthetic growth substances whose biological effects resemble them. In this field research work is probably in its infancy, but the results of investigation to date are of fascinating interest. Mr. Nicol, who has thoroughly surveyed the existing literature on the subject, has compiled a study which as a work of reference should meet a wide demand.

The New Farming. By D. H. Robinson. Pp. xii + 180. Illus. (London: T. Nelson. 1938. Price 2s.)

By "new farming" the author means the co-operation of science with the art of farming, or, in other words, the contribution which science has made in approximately the last fifty years to agriculture. The author is to be congratulated in covering so wide a field in a small volume of under 200 pages, and in telling the story in a thoroughly readable way. Each department of farming is dealt with in turn—the new knowledge concerning the soil, plant and animal breeding, disease control, etc. Naturally, the information is compressed and implies a certain background of knowledge, but it is so clearly expressed as to be of real service to the general reader.

Forty Acres and Steel Mules. By H. C. Nixon. Pp. 98. (The University of North Carolina Press. 1938. London: Oxford University Press. Price 11s. 6d.)

A recent survey by the National Emergency Council of the United States revealed that the Southern States, capable of producing almost everything in abundance and with more than half the nation's farmers, were growing less than one-fifth of the things they used, and were for a large part nothing better than a vast rural slum. The housing conditions were summed up in the Commission's Report with: "By the most conservative estimates, 4,000,000 Southern families (18,000,000 people) should be rehoused."

The author of "Forty Acres and Steel Mules" knows this tragic South intimately. In his own words, he has carried on research "among human beings on an Alabama upland plantation over two decades." He has made an attempt not only to interpret the region in the light of the inevitable trend of the time, but to suggest proposals for its improvement, a task of great difficulty, for he is confronted both with an immense accumulation of material decay and with the discouraging "pay-day" philosophy of the Negro who can say "The eagle on the dollar means to let 'er fly and I lets 'er fly." This book is clear-sighted, well written and fascinatingly illustrated in a manner that suggests the documentary film.

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A Guide to Veterinary Parasitology and Entomology for Veterinary Students and Practitioners. Second Edition. By T. Southwell and A. Kirshner. Pp. xvi + 176. Illus. (London: H. K. Lewis & Co., Limited. 1938. Price 10s.)

It has, for years, been one of the guiding principles in teaching at the Liverpool School of Tropical Medicine, where the authors are placed, that during the limited time at the student's disposal it is only possible to provide him with the essential outlines of the subject, to be consolidated and amplified by his subsequent experience.

The authors of this book have closely followed this excellent principle, and in condensing the subject to the last degree have shown great skill in their selection of the essentials, and the many years teaching experience of the senior author is reflected in every section.

The excellent diagrammatic illustrations, which are among the best of their kind to be found anywhere, are a most notable feature of the book, and the numerous tables of differences, lists of species of parasites grouped under various headings, host parasite list, and list of parasites of meat and fish, to mention only a few of the aids to learning, will be of the greatest help to the student.

It might be thought unfortunate, in view of the importance of coccidiosis, that no mention is made of the multiplicity of the species concerned, and that trichomonas and its association with abortion in cattle is not mentioned. The omission of a mention of gland puncture in the diagnosis of East Coast Fever was also observed but there is room for diversity of opinion with regard to omissions in writing a condensed book of this kind and such criticism can hardly be permitted.

In the second edition the book has been enlarged by some thirty-two pages in which a section on entomology is added to those on protozoology and helminthology. This is a most excellent "cram" book; it will doubtless be a favourite with students, and in the reviewer's opinion deserves a wide success.

The Handbook of British Birds. 2nd Volume. By Witherby, Jourdain, Ticehurst and Tucker. Pp. xiii + 352 and 30 plates. (London: H. F. & G. Witherby, Ltd. 1938. Price 21s. net.)

In the second volume of the new *Handbook of British Birds*, both authors and publishers have maintained the high standard of the first. There is little more that need be or can be said in praise of this excellent work, except that with the successful portrayal of the various warblers a most difficult obstacle has been surmounted.

The only fault of any importance is the omission of an illustration of the grey phase of the Tawny Owl, which we think is rather less rare in the country than it is stated to be.

We have seen no suggestion of a series of plates of eggs, and it is presumed that this is not contemplated by the authors. It is true that illustrations of eggs are not essential to a work which, after all, is one on birds, but, nevertheless, we hope that it may be found possible to include these in some later volume, perhaps in the form of an appendix to the final one.

Commercial Fruit and Vegetable Products. By W. V. Cruess. Pp. x + 798. Illus. (London: McGraw-Hill Publishing Co., Ltd. 1938. Price 36s.)

The second and considerably enlarged and revised edition of Professor Cruess's *Commercial Fruit and Vegetable Products*, running to some 300,000 words and including over 100 illustrations, is one of the most comprehensive works ever attempted on this subject. Professor Cruess's close

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contact with food industries in California guarantees a practical handling of the technical problems.

The work is designed primarily for students and is probably the only text-book in English that can fill the needs of a graduate course. In addition, it appears to be an excellent work of reference for technicians.

Written for American conditions, it deals with a much wider range of products than can be grown in this country, although practically all are grown in one or other part of the British Empire.

Over one-third of the book deals exhaustively with every aspect of fruit and vegetable canning; other sections deal with fruit products, pectin, jams, dried fruits and vegetables, vinegar, pickles, wines, frozen fruit and vegetables and various by-products. There are interesting chapters on vitamins, plant pigments and enzymes.

The index is good but by no means exhaustive.

On Agricultural Policy. 1926-1938. By Joseph S. Davis. Pp. viii + 494 (California : Food Research Institute, Stanford University. London : P. S. King & Son. 1938. Price \$3.)

This is a book of addresses on Agriculture and Agricultural Policy delivered by Dr. J. S. Davis to a great variety of audiences in the period 1926-1938. To read this book with profit, the reader should have at least some understanding of the American background because the addresses deal exclusively with American problems and American conditions. Dr. Davis has been engaged in studying the various aspects of food production over a long period, and the fact that he served for a time as chief economist to the Federal Farm Board and is a Director of the Food Research Institute will be sufficient indication of his wide outlook. The addresses are grouped together in a way which gives the book some coherence, but for English readers who want an exposition of the problems of American Agriculture viewed as a whole the book may not seem wholly satisfactory, in that it is discursive and lacking in detail.

Statistical Methods applied to Experiments in Agriculture and Biology. By George W. Snedecor. Pp. 356 (Ames, Iowa, U.S.A.. Collegiate Press Inc 1937. Price \$3.75.)

The writer who wishes to expound modern statistical methods to workers in the non-mathematical sciences has to steer a tortuous course between the Scylla of employing an advanced mathematical technique and the Charybdis of compiling a list of recipes which give their user no idea what he is doing.

Professor Snedecor makes a valiant attempt to reach a safe harbour by steering a different course from his predecessors. Whether he has succeeded must be determined by the reception his book receives from the class of research workers and students to whom it is addressed.

Briefly, this book sets out to give to experimenters in biology, agriculture and allied sciences a working knowledge of a statistical technique sufficient to enable them to design their experiments efficiently and to assess the significance of their results. Very wisely, Professor Snedecor makes haste slowly, appealing at various stages to experimental support of the theory and giving numerous practical examples on which the reader can test his knowledge of the rules.

Perhaps it may be suggested that Professor Snedecor has gone a little too far in avoiding theoretical considerations. The various tests of significance which he discusses are most if not all dependent for their validity on the normality of the universe from which the samples are derived; but this cardinal fact rather tends to be ignored when the tests are applied to specific data. Again, Professor Snedecor usually appeals to

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experiment in discussing random sampling distributions without giving an adequate discussion of how randomness is to be secured. For agricultural or biological purposes, perhaps, these points are not of great importance to the student since biological distributions are often close enough to normality and Nature is generally assumed to provide us with random samples from them; but in other branches of science they are vital.

Some slips in the index and the text have been noted. So well known a name as Mr. Udny Yule's is constantly mis-spelt. Professor R. A. Fisher's book on "Statistical Methods for Research Workers" is sometimes referred to the date 1925 and sometimes to 1936. On page 29 it is stated that the normal curve contrasts sharply with a previously given distribution of X^2 for one degree of freedom. This is true in a sense, but since the X^2 distribution in this case is merely the positive half of a normal curve, some happier phrasing might have been found. In a work such as this, however, full of tables and figures, some errors are inevitable and they appear to be commendably few.

From Garden to Kitchen. By C. H. Middleton and Ambrose Heath. Pp. 224. (London: Cassell & Co., Ltd. 1937. Price 3s. 6d.)

The object of this little book is to help the gardener to produce good vegetables by giving him the outlines of their cultivation and indicating the different ways of cooking the various vegetables. Ambrose Heath, in the section on cooking, has accepted the principle that food "eats good that looks good." This is an interesting and useful book that should become popular.

Parasitology. By Hegner, Root, Augustine, Huff. Pp. xxi + 812. Illus. (London: D. Appleton-Century Company. 1938. Price 25s.)

This book is a revised and enlarged edition of one published by Hegner, Root and Augustine some nine years previously under the title *Animal Parasitology*.

Following a brief introduction by the senior author, the book deals with the more important parasites of man and the domestic animals in three sections, "Protozoology," by Hegner, "Helminthology," by Augustine, and "Entomology," by Root; this section, owing to the death of Dr Francis M. Root, has been revised by C. G. Huff. As one of its aims is to be of service in the teaching of parasitology, a few of the most prevalent parasites of the common wild animals are included because of their availability, or their special value for teaching.

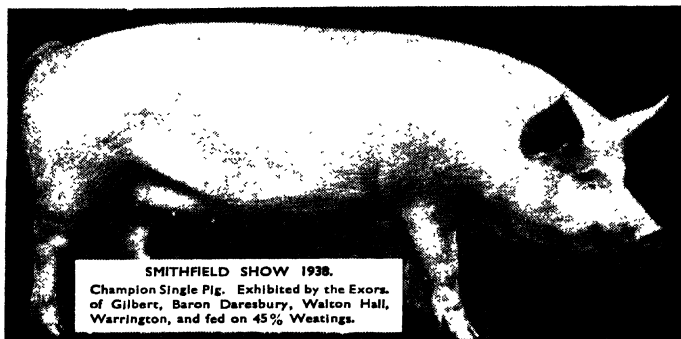
It is impossible to deal at all fully with such an enormous range of subjects within the compass of some 800 pages, so that much has necessarily been omitted. One would, however, like to have seen some mention of Tyzzer's work on coccidiosis, and the multiplicity of species involved; and of recent work on the life histories of the lungworms of sheep and of Well's work on the blood sucking activities of *Ancylostomac*. Although the index is very brief, the bibliographical list extending over 80 pages is most useful; the selection of the more important points from the great mass of available information must be acknowledged as good. The numerous illustrations are also well chosen and the book should serve a very useful purpose as a manual for students and for the use of practising veterinarians and physicians.

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THE JOURNAL OF THE MINISTRY OF AGRICULTURE

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MAY 1939

Poultry Industry Bill

This Bill has recently been introduced to give effect to the policy for the poultry industry outlined in a statement made by the Minister in the House of Commons in July last, a copy of which appeared in this JOURNAL for August, 1938 (p. 427). The principal provisions of the Bill fall into two groups, concerned respectively with the improvement of the health and quality of the fowl population and the marketing of poultry products.

The administration of these and certain other provisions of the Bill will rest with an independent Poultry Commission consisting of a Chairman and not more than eight other members appointed by the Minister of Agriculture and Fisheries and the Secretary of State for Scotland. The Commission will be assisted in the discharge of its functions in relation to stock improvement and marketing by a Stock Improvement Advisory Committee and a Marketing Advisory Committee respectively, each consisting of members representative of the various interests concerned, together with not more than four additional members appointed by the Ministers. In addition to its other functions, the Commission will be responsible for advising and assisting the Ministers in matters relating to the poultry and egg industry. The Bill provides for the cost of the Commission being borne by the Exchequer.

Under the provisions relating to the improvement of poultry stock, the Commission will be required to register all distributors of fowls not intended for immediate slaughter and eggs for hatching. The Commission will be empowered to make regulations to be observed by such distributors, for example, for preventing the use of unsuitable birds for breeding purposes and for the notification of disease on their premises. The Commission will also be required to frame a breeders' accreditation scheme, on voluntary lines, assisted by premiums from the Exchequer, and a hatcheries accreditation scheme.

The main purposes of the provisions relating to marketing will be to secure that home-produced eggs and poultry, when bought by consumers, are graded for quality and size, and that the responsibility for grading shall ordinarily be borne by the wholesale trade. After an appointed day, it will be an offence to sell a poultry product (i.e., dead poultry, eggs and egg products) unless it is graded and marked in the appropriate manner. Producers of eggs and poultry who sell their own produce, and hotel and restaurant sales, will not be subject to this requirement; and provision is made for the granting of such further exemptions as the Commission may decide upon.

The Bill provides for the marking of preserved eggs and the registration of all premises used by way of trade for the cold storage or chemical storage of eggs; and the Commission will be empowered to require all eggs to be suitably marked either before going into, or before coming out of, storage. It is also provided that the importation of eggs into the United Kingdom will be prohibited unless either the eggs bear marks indicating preservation, or a direction has been given or a licence has been granted by the Minister waiving this requirement, subject to specified conditions.

Other provisions of the Bill relate, *inter alia*, to the regulation of imports of poultry and poultry products; the making and administration of service schemes for certain purposes connected with the welfare of the industry; and loans up to a maximum of £50,000 to producers' co-operative egg and poultry packing stations.

Report of the Departmental Committee on the Imposition of Penalties by Marketing Boards and Other Similar Bodies

In recent years there have been several examples of legislation providing for the organization of agriculture and other industries on self-governing lines by means of statutory schemes. Following the precedent of the Coal Mines Act, 1930, this legislation has generally provided for the maintenance of discipline—which is obviously necessary if the schemes are to be fully effective—by the body administering the scheme. Thus, under the Agricultural Marketing Act, 1931, marketing boards were empowered to impose penalties upon registered producers who contravened the provisions of the marketing schemes or the directions of the boards.

These arrangements have given rise to certain criticisms, and during the passage of the Sea Fish Industry Act, 1938, the then Minister of Agriculture gave an undertaking to consider the question of penalties under marketing legislation generally. As a result of this undertaking, a Departmental Committee was set up under the Chairmanship of Viscount Falmouth to inquire into the arrangements for the imposition and recovery of penalties by agricultural marketing boards and similar bodies. The Committee examined the arrangements for the imposition of penalties for contravention of schemes under the Agricultural Marketing Acts, the Sea Fish Industry Act, the Coal Mines Act and the Herring Industry Acts.

Although the Committee's report,* which has just been published, is concerned principally with the agricultural marketing schemes, it will be of wider interest because the inquiry involved consideration of the general principle of providing "domestic" courts for dealing with offences under statutory schemes. The Committee refer to the two main criticisms that have been made against the system on grounds of principle, namely that it contravenes the so-called "Rule of Law" and that the bodies imposing the penalties are prosecutor, jury and judge in their own cause. They do not, however, accept the contention that no person should be penalized except in a court of law. They point out that similar arguments could be applied to a whole class of industrial and professional associations, and they express the definite opinion that, subject to certain safeguards being provided, offences under the marketing and similar schemes should be dealt with by domestic tribunals and not in the ordinary Courts.

As far as the agricultural marketing schemes are concerned, the Committee's recommendations are, therefore, designed to improve the existing system in the light of the experience that has been gained. Their principal recommendation is that under each scheme a disciplinary committee, consisting of not more than 5 persons, should be set up to deal with offences. The chairmen of these committees should be independent persons with legal qualifications and experience, appointed by the appropriate Minister. The members of each committee would be members of the marketing board concerned, and

* Report of the Departmental Committee on the Imposition of Penalties by Marketing Boards and other similar Bodies, Cmd. 5980, published by H.M. Stationery Office, price 1s. net.

might include representatives of any special interests on the board when cases affecting such interests were being heard.

The Committee do not consider it necessary that evidence before the disciplinary committees should be on oath, nor that witnesses should be subpoenaed to attend. They recommend, however, that certain further particulars of the case against a producer should be disclosed to him in advance of the hearing. The Committee think that a *regular* system of provincial meetings of the disciplinary committees would be impossible, although they recommend that meetings should be held in provincial centres whenever possible. The Committee explain that the penalties inflicted by the Milk Marketing Board are sometimes apparently large because they make allowance for the losses caused to the fund of the Board by an offender. They recommend that such losses should in future be recovered separately and not as part of the penalty. The Committee recommend that the right of appeal to an arbitrator should continue, but that there should also be a right of appeal from the disciplinary committee to the High Court on questions of law. Other recommendations of the Committee concern the procedure of the disciplinary committees, the manner in which penalties should be recovered and certain matters arising under the Bacon Industry Act.

As regards the Coal Mines Schemes, the Committee point out that the nature of the penalties imposed and the procedure adopted are quite different from those under the agricultural marketing schemes. The Committee received unanimous evidence that the schemes are working smoothly and are giving general satisfaction, and they recommend no alteration in the present arrangements.

As regards the Herring Industry Scheme, the Committee say that the particular circumstances of this industry seem both to favour and to require local disciplinary tribunals; and they recommend, in this special case, the constitution of a limited number of district disciplinary authorities, each consisting of an independent adjudicator with legal experience, sitting with two assessors.

THE SOUTH LINCOLNSHIRE BULB INDUSTRY

J. C. WALLACE AND D. E. HORTON,

Agricultural Institute and Experimental Station, Kirton

History. The bulb industry in this country is of comparatively recent development. The growing of bulbous flowers, such as daffodils and tulips, for the market dates back to a little more than fifty years, and it is only within the past decade that serious attention has been given to the production of bulbs for what is known as the dry-bulb trade. In the 'seventies of the last century, some small transactions in snowdrop bulbs was the extent of the bulb industry in South Lincolnshire, and it was in the early 'eighties that the first consignment of daffodil flowers was sent to Covent Garden by that pioneer of the industry, the late Mr. J. T. White. Mr. White's first transaction in bulbs was the purchase of a few hundred daffodils. In those early days the flowers sent to market were packed in wicker hampers, the packing material being old newspapers, and the few hampers forwarded were taken to the station in a hand cart. From this small beginning, the demand for daffodils and tulips, and much later iris, gradually increased.

As a contrast to these early days and as evidence of the great growth that the industry has made it may be remarked that the firm founded by the late Mr. White has on some recent occasions forwarded no less than 2,000 boxes of flowers in one day. The hampers have been superseded by proper flower boxes, and the old newspapers have given way to grease-proof paper; the flowers are properly graded, neatly bunched, and so treated and packed that they arrive in the markets in a perfectly fresh condition.

By the early years of the present century the area of bulbs in the Holland Division had increased to over 500 acres. During the War, the industry had little chance of development as much of the land was devoted to food production, but afterwards the increase was rapid, until by 1930 it is estimated that in South Lincolnshire the acreage had increased to nearly 2,000. The great bulk of this acreage was devoted to flower production.

LINCOLNSHIRE BULB INDUSTRY

At the beginning of the century, more attention was being devoted to the forcing of flowers under glass, and there was great development in the erection of glasshouses for this purpose. To-day, almost every grower has one or several forcing houses, and some of the larger firms have from four to eight acres of glass as well as several acres of Dutch lights for placing over tulips planted out-of-doors. These Dutch lights not only encourage much earlier flowering, but they protect the flowers from the weather.

So far, the industry was primarily concerned with the cut-flower trade. A portion of the bulb crop was used for forcing, and some small exchange of dry bulbs did take place with other forcers; but the continuous cropping of the flowers for market resulted in the gradual deterioration of the stocks, and supplies had to be made good by the purchase of imported bulbs. The forcing industry, not only in the Holland Division of Lincolnshire, but in other parts of the country also, depended very largely on imported bulbs. It may be remarked that tulips are discarded after forcing, as are most daffodils, and hence continuous fresh supplies are required.

Before 1930 very little attention was paid to bulb production, either to maintain stocks or to supply the retail trade, which up to that time dealt almost entirely in imported bulbs. It was generally assumed that bulb production could not be successfully carried out in this country. Some of the larger growers were admittedly refraining from cutting a portion of the tulip crop which they intended to use for forcing, and were finding some outlet for surplus bulbs for this purpose. In 1916, the Royal Horticultural Society, because of the scarcity of imported bulbs during the War, held a conference to discuss the possibility of producing bulbs in this country, but the general consensus of opinion was that the prospects were not bright. In 1930, however, some of the bulb growers in South Lincolnshire, basing their opinion on the reasonable success which had attended their own small efforts at bulb production, asked the Holland County Council to undertake investigations at the Kirton Agricultural Institute, and a Bulb Research Sub-Committee of the Agricultural Education Committee was formed for this purpose.

The investigations soon showed that, provided proper methods were adopted, bulbs equal to those imported could be grown in South Lincolnshire. These investigations, together with the publicity given to British bulbs by the Empire

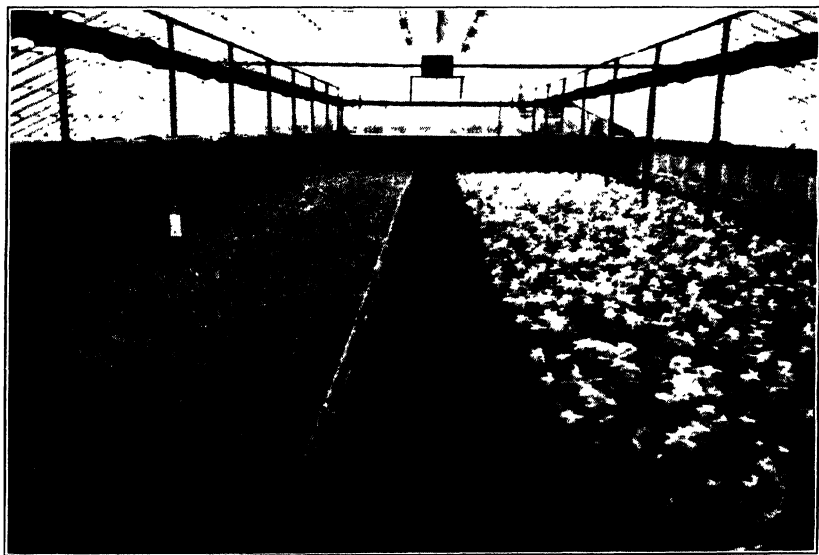
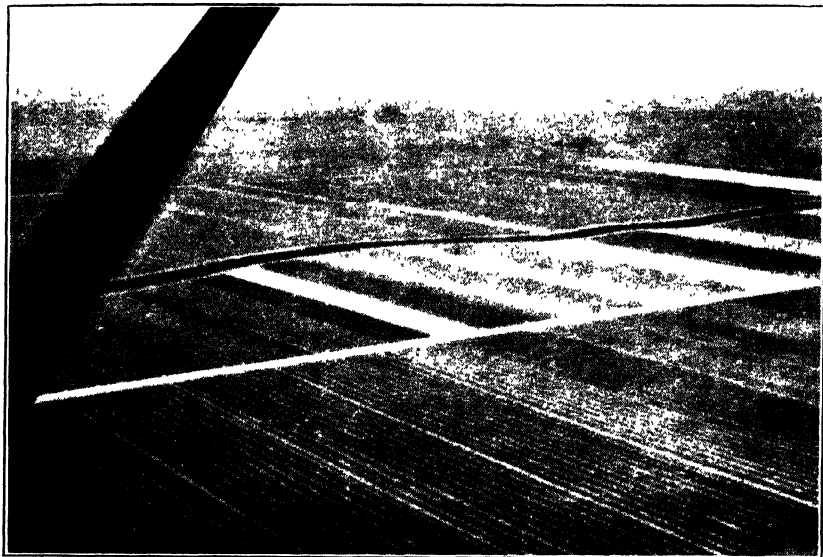


FIG. 2 Bulb growing under glass *Right, bulbs specially treated for early flowering*
To face p 110

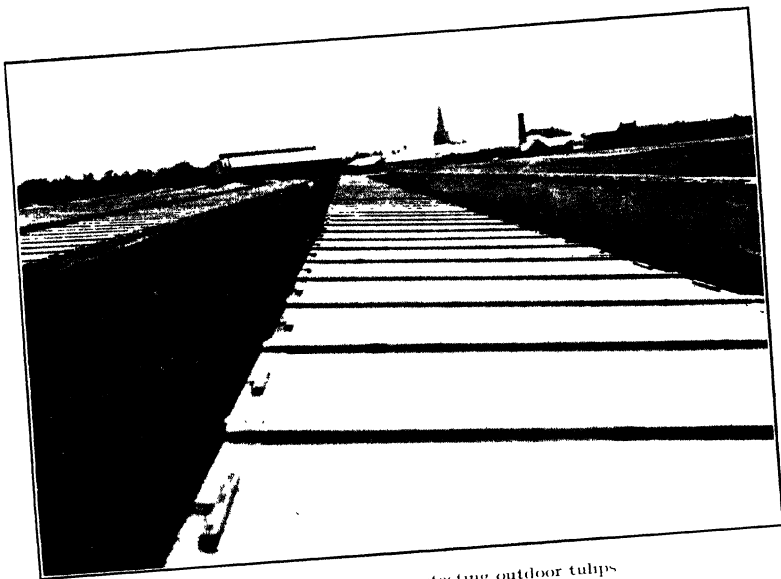


FIG. 3 Dutch lights protecting outdoor tulips

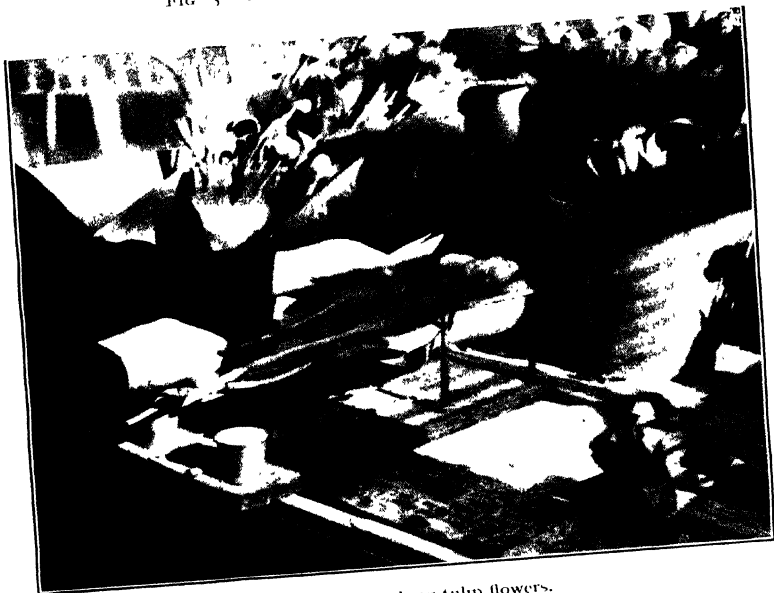


FIG. 4 Bunching tulip flowers.

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Marketing Board, and later by organizations of the industry itself, gave an impetus to bulb production, and so rapidly has the industry developed that in 1938 there were between 4,000 and 5,000 acres of bulbs in the Holland Division. The greater part of this acreage consists of daffodils and tulips, but during the past few years hyacinth propagation has been taken up, and last year there were over 50 acres of home-grown hyacinths in South Lincolnshire. There is also a comparatively small acreage of iris, and a few growers have now turned their attention to lilliums and fritillaria.

General Organization. The industry may be roughly divided into the following branches: 1. Out-door cut flowers; 2. Forced flowers; 3. Bulb production (as distinct from flower growing.) The experiments at the Kirton Agricultural Institute soon showed that satisfactory bulb production could not be carried on with stocks which were also used for the cut-flower trade, hence bulb production has come to be regarded as distinct from the cut-flower trade, even if practised on the same farm.

The majority of growers now engage in all three branches of the industry. A few growers have developed the forced cut-flower branch, and have ignored the dry-bulb trade, i.e., the production of bulbs for forcing and for the retail trade, whereas others have devoted their energies to the latter. It may be stated that the increase of nearly 3,000 acres of bulbs which has taken place since 1930 is almost entirely for bulb production.

The disposal of flowers is through the wholesale merchants in the towns, but a few growers do some retail trade from stalls on the roadsides with the many visitors who visit the bulb fields during the flowering season.

The bulk of the dry-bulb trade is also wholesale, although a considerable retail trade has been developed by some growers, contact being made partly by advertisements in the press and partly direct with visitors to the bulb fields.

Work continues at a high pressure for the greater part of the year. Large numbers of women are employed, chiefly for the lighter operations, such as cutting the flowers, grading and bunching, and for planting, lifting, cleaning and grading bulbs. Employment is continuous, except for a few weeks during winter. Male labour is used for the heavier operations, and is generally permanent. The season commences

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with the planting of the bulbs out-of-doors in the autumn. At about the same time, the boxing of the bulbs for forcing begins. This is followed by the housing of the bulbs for forcing and the marketing of indoor flowers. In March, the out-door flower season commences. Much labour is necessary to keep the bulb fields free from weeds, and for the "topping," i.e., the removal of the flower heads, of the stocks used for bulb production. This is followed by the lifting of the bulbs and their removal to the warehouses where they are cleaned and graded.

The equipment of a modern bulb farm is extensive and expensive. Specially-constructed, artificially-heated warehouses are necessary for tulips, cool warehouses for daffodils, cold storage plant for preparing bulbs for early forcing, special chambers for hyacinth propagation, packing sheds for packing the flowers and bulbs, hot-water sterilizing plant for the control of eelworm in daffodils, etc.

Tulip and hyacinth bulbs are lifted every year, cleaned and graded into sizes according to requirements, i.e., for forcing, for the dry-bulb trade, and for re-planting to maintain and increase the stock. Daffodils for the dry-bulb trade are lifted each year, but for forcing, and more frequently for the cut-flower trade, they may be left down for two years.

The Cut-flower Trade. The season commences about Christmas, the earliest forced flowers being obtained from bulbs specially treated in cold stores. After the bulbs are lifted in the previous autumn, certain sizes and weights are selected for forcing; these depend upon the kind of bulb and upon the variety. Those for early flowering are transferred to cold store. In September and October these and the untreated bulbs for forcing are planted in boxes which are placed on the ground outdoors and covered with straw or soil. Varieties suitable for early forcing are transferred to the greenhouses in early December. As soon as the flowers have been marketed, the boxes are removed and the house again filled. This is repeated three, and occasionally four, times. When the last lot is finished the house is planted with tomatoes. Great care has to be taken to ensure correct temperature during forcing. Thermostatic control and automatic stokers are in common use.

A greenhouse 25 ft. wide by 100 ft. long will hold approximately 64,000 bulbs. The first "round," i.e., the bulbs placed in the greenhouses in early December, takes from 4

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to 5 weeks to flower. Subsequent " rounds " take from 3 to 4 weeks. The treatment in the glasshouses has to be varied according to the kind and variety of bulb being forced. Some kinds require a dry atmosphere, others a moist one. Some varieties of tulips are grown on staging with the hot-water pipes beneath. Other varieties are grown on the floor of the greenhouses, with overhead heating.

Both indoor and outdoor flowers are cut before they are fully open, the cutting being done by women. They are tied into regular bunches of 25, every care being taken not to bruise the flowers, placed in trays or hampers and taken to the packing shed, where they are put with their stems in water in buckets or shallow tanks, the atmosphere being kept cool. Later they are prepared for market. Bunching is carried out by women, many of whom become highly expert at the work. A recognized standard is 60 bunches of daffodils or 45 bunches of tulips per hour. The flowers are graded according to size and quality. Special frames are used for bunching, daffodils being arranged with their flowers facing in one direction, and tulips with their flowers at one level.

Flat boxes or trunks are used for sending the flowers to market. Only one layer is placed in each box and the bunches are securely fastened to prevent movement during transit. Each box is labelled both inside and out with the name of variety and the number of bunches, etc. Every endeavour is made to ensure that the flowers arrive absolutely fresh on the market. Further, the growers fully realize the necessity for the flowers lasting after purchase, and the treatment from cutting onwards is designed with this object in view.

Forcing is expensive, and good prices must be realized for the flowers if it is to be profitable. The bulbs alone may cost $\frac{1}{2}d.$ - $1\frac{1}{4}d.$ each, according to variety, and forcing expenses may in some seasons reach as much as 50s. per 1,000 bulbs. To this must be added depreciation of greenhouses and forcing boxes, and transport and selling expenses.

The bulk of the flowers, both forced and out-of-doors, are sent to market by rail, but of recent years lorry transport has taken some part of the trade. Some of the larger growers use their own lorries in addition to sending by rail. Lorry transport firms have recently developed services direct to certain towns, the loads being made up by

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consignments from the smaller growers. These services leave the district as late as 10 P.M., thus giving the growers a much longer time to get the flowers ready for market.

To give some idea of the size of the South Lincolnshire flower industry, it may be stated that as many as 2,000 tons of flowers have left Spalding station alone in one day. This means about 375,000 boxes of flowers. Boxes hold 12-18 bunches.

Bulb Production. As previously stated, bulb production is now regarded as a separate branch of the bulb industry. It differs from flower production in that the object is to produce a high percentage of bulbs suitable for the dry-bulb trade. In the first place it demands the growing of a much larger number of varieties than is required when the cut-flower trade is the object of the grower. Secondly, it demands much greater care in the selection of sizes of bulbs, and in the maintenance of vigorous stocks. It even demands closer attention to the maintenance of healthy bulbs.

To meet the demands of the dry-bulb trade, many growers now have hundreds of varieties of daffodils and tulips under cultivation, and have extended the range of kinds to include hyacinths, crocus, scillas, iris, etc.

Lifting of the bulbs takes place in July and August, the bulbs being immediately transferred under cover, for cleaning and grading. Special attention is given to grading, as the price obtainable for dry bulbs may differ greatly according to size. For instance, the difference in price between a 10 cm. and a 12 cm. bulb may be as much as 25s. per 1,000. Most growers now possess efficient grading machines, which grade very closely to size, and, what is equally important, do not damage the bulbs. A point seldom realized by purchasers of bulbs is that rough handling may seriously affect the subsequent growth of the bulb. Certain sizes are required for the retail trade, generally the larger sizes, but the largest bulbs are now usually retained for stock purposes. Other sizes are required for forcing, and here the weight of the bulbs has also to be considered. Finally, the sizes for replanting out of doors are selected.

Narcissus bulbs are stored under cool conditions, whereas tulips are kept at higher temperatures, depending upon the purpose for which they are required. Most growers now possess elaborate and efficiently equipped warehouses, provided

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with means to keep the air at the temperature required. Tulip bulbs for the retail trade are kept at a moderate temperature, those for replanting in the fields at a higher temperature. All narcissus bulbs for replanting in the fields are subjected to hot-water treatment. This is given to control eelworm, etc., and consists of keeping the bulbs for a certain period in water at a temperature of 110° . Special plant for hot-water treatment has been erected on most bulb farms. Bulbs for the retail trade or for forcing are not subjected to this treatment.

Unlike the Dutch system of storing the bulbs in the warehouse in fixed shelves, the method in South Lincolnshire is to place them in shallow trays fitted with raised handles at either end, which permits of the trays being stored one above the other with a sufficient space between each box to allow of adequate air circulation. Further, this method allows of better attention to hygiene, as the trays can be easily dipped in a sterilizing solution, and the warehouse more easily cleaned.

Planting of the bulbs out-of-doors commences in August and is carried on throughout September and perhaps the early part of October if weather has delayed the work. The importance of early planting is realized, particularly with daffodils, and work therefore is continued at very high pressure owing to the short period of time available.

The bulbs are "ploughed in," that is to say a furrow is opened with a special plough, the bulbs being carefully placed by hand along the bottom, and then covered with the next furrow "slice," so that, when growing, the bulbs are in uniform rows nine inches apart. Every sixth furrow is left unplanted, and the bulbs therefore appear to have been planted in beds with a path between each. This path is for the purpose of carrying out the various cultivations, or for cropping or heading the flowers, without walking on the beds and thereby injuring the foliage—a factor of much importance.

Much labour is expended on keeping the fields free from weeds, but this becomes difficult after the flowering season, especially with daffodils, the foliage of which falls over and renders the use of a hoe impossible. Unfortunately, weeds grow very rapidly in South Lincolnshire soils, and seeing the amount of weeds in some bulb fields at the end of June, it is difficult to believe that they were quite clean a few weeks previously.

Throughout the growing season the fields are continuously

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under inspection, and all plants showing disease are removed. During the flowering season "rogues" are taken out. Stocks of bulbs reserved for the dry-bulb trade, i.e., for all purposes other than the outdoor flower trade, have the flower heads removed when the flowers are fully opened. A sharp knife is used and the flower stem cut through just below the flower head. With hyacinths, however, the florets are stripped off the stem by hand. The flower heads are not dropped on the soil, but collected in baskets and removed from the field.

The weight of bulbs planted per acre is from 2 to 3 tons, and the value varies from £30 to £50 per ton, according to kind and variety. These prices are, of course, for standard varieties. New varieties command high prices, which may range from £5 to £50 per bulb.

The planting of the bulbs is done by women, usually in gangs of eight, and the average rate of planting is half an acre per day. The cost of planting is approximately £7 10s. per acre, this figure including the transport of the bulbs to the field, man and horse for ploughing, etc.

Good bulb land is expensive and may command from £90 to £130 per acre. The former figure is, of course, nearer the average. Owing to the desirability of securing a rotation of crops, many growers are now renting land from farmers further afield, the bulb grower supplying the bulbs, the farmer supplying the labour, and working under the direction of the bulb grower.

Bulb land must be kept in good condition, and as the bulb crop is an exhausting one, it cannot be successfully grown too frequently on the same land. On the larger bulb farms, from one-quarter to one-third may be under bulbs, which generally follow potatoes. As bulb planting takes place in August and September, it often means that much of the land has to be left vacant during the early part of the year.

The labour required on a bulb farm is very great in comparison with agriculture or even horticulture. On a farm growing 250 acres of bulbs, over 200 men and women would be more or less continuously employed.

BUILDING UP A SMALL DAIRY FARM IN SOMERSET

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The present article is a description of the methods adopted on a small dairy farm run by Messrs. Newman and White. The farm has been selected, not because of any "stunts" practised on it, but simply to illustrate how attention to detail, especially in connexion with correct feeding for milk production, can improve profits. In fact, one can say simply that the policy followed on this farm since it was purchased in February, 1927, is to produce milk of the best quality at the lowest cost, with, of course, the idea of obtaining maximum profits.

Walscombe Farm is situated well away from the main road and is about two miles from the small country town of Chard, Somerset. It is more or less circular in shape, and the farm buildings are situated near the centre of the land, which is, in the main, undulating in character. The soil ranges from a light sandy loam at the top of the farm to a heavier clayey soil at the lower end, and contains throughout a good proportion of stone. The actual geological formation of this part of Somerset is classed as Stonebrash and is not generally rated at more than second-class soil.

Only 11 of the 120 acres consist of arable land, and this is used mainly for the production of fodder crops for cows. Approximately four acres each year are, however, used for the production of wheat or oats, so that sufficient straw may be available for use as bedding for the cows. As this is not an arable district, straw is very difficult to obtain. Besides the cows, poultry and sheep have lately been added. In the early years, a few pigs were kept, but the difficulty of keeping them isolated from the cows has caused them to be dropped for the present, as, since the herd is Attested, this isolation is considered essential. The keeping of breeding sows, which must be run out, is precluded. Consideration is now being given to the possibility of buying stores and grading them up for bacon, partly with a view of making more dung in order to have sufficient to be able to manure one quarter of the acreage each year.

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At the time of entry to the farm it can be said that everything was bad. The land was in a very poor condition, nothing had been put on it, or in it, for years. The buildings were also bad. There was hardly a decent building in the place and all had cobblestone floors, which, of course, harbour dirt and are hopeless in the cowshed if any attempt is to be made to produce clean milk. A great number of improvements have been carried out, although much work still remains to be done, and nearly all that has been done has been performed by men working on the farm.

Obviously, another initial difficulty was that it would have been impossible to put additional stock on the farm before either the land or the buildings were capable of accommodating them. From 10 to 12 cows was the extent of the dairy herd.

Throughout the whole ten years the farm has been built up out of profits; a sort of ploughing back plan has been followed. The financial crisis of 1931 and the trade depression of subsequent years have, unfortunately, considerably retarded progress and made the struggle still more difficult.

For the last eight years the farm accounts have been analysed by Bristol University and the profits show a continuous improvement throughout. Since the farm is practically entirely devoted to milk production, it is thought that the following figures of milk sales may be of interest:—

Year	1931	1932	1933	1934	1935	1936	1937	1938
£	804	485	574	731	702	658	1247	1593

Until and including the year 1936, the whole of the milk was sold to a local factory. In 1937, a two-years' contract was agreed with a London buyer, and as the herd was then producing T.T. milk this contract was not affected by the Milk Marketing Board. The result of the higher prices obtained under this contract is clearly seen in the values of sales given in the previous table.

In the early days of T.T. milk, before much attention at all was paid to it by the ordinary farmer, steps were taken on Walscombe Farm to grade up the herd for the production of such milk. There were at that time twenty cows on the farm, all cross-bred Shorthorns. The first test resulted in eight reactors. These were kept isolated from the remainder, and, as they calved down, were sold and replaced partly by home-bred and partly by purchased stock.

As soon as the Accredited Milk Scheme was inaugurated,

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the herd was able to be placed upon the Accredited Roll, but Messrs. Newman and White felt that the extra penny per gallon was scarcely worth the extra cost and trouble involved. Had it not been that the Accredited licence was but one step towards the goal of T.T. milk from an attested herd it is quite probable that no sustained effort would have been made to remain on the Accredited Roll.

When the Attested Herd Scheme came into operation it appeared to be so full of restrictions that it was "shunned" for twelve months. The greatest problem was how to make good the number of cows if and when a proportion of them was rejected, or if purchases had to be made to keep up the level deliveries of milk required under the contract then running. Although the herd had always consisted mainly of cross-bred Shorthorn cows, there were by now a few non-pedigree Friesians, and for several reasons it was decided to concentrate more upon Friesians in future.

It may be mentioned that no special enthusiasm was felt for the Friesian at that time; in fact, nothing was then known of them except that the one or two then on the farm appeared to do better and certainly gave higher yields. Neighbours were more than dubious about Friesians; they were emphatic that they were totally unsuitable for the district. One criticism was that the land would not be able to carry so many cows, but in fact this has not happened. The stock-carrying capacity of the land is not affected by the replacement of Shorthorns with Friesians, and the total milk output has increased.

In April and December, 1935, the first two pedigree Friesian cows were purchased, both in milk, and both turned out to be reactors. This was, to say the least, a disappointing start, and the plan of proceeding towards a high output of best quality milk seemed doomed. It was decided to persevere, however, and no Friesian cow has ever reacted since.

As time passed and it was realized that the Friesians were successful, it was decided to build up and convert the herd into a pedigree Friesian one, and this is still in process. The Friesians all do better than the cross-bred Shorthorns; they keep in condition better; they give more milk and keep up their higher yields for longer periods. As stated above, no brief was held for the Friesian breed; any other breed would have been equally welcome on this farm if it proved to be as satisfactory.

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The herd became attested in April, 1938. This was later than was at first hoped, but delay was due to one Shorthorn heifer reacting, a home-bred heifer which had never been inside a building and had passed six previous tests, having had tests from a calf. The heifer was put back for a fortnight and then retested, but as it still reacted the animal was sold, and at the next test the whole herd passed.

Apart from the necessity of testing the herd for purposes of the Attested Herd Scheme, the test is regarded by the two partners as valuable in that it enables them to keep a check upon the general health of the herd. The cows are definitely more free from other complaints; there has been no sterility or contagious abortion, and, when one hears and reads about the prevalence of these two scourges, this is a good deal to be thankful for.

In future, all animals will be home-reared, as there is a risk that purchased T.T. cows may bring abortion or mastitis on to the farm. In order to have sufficient room to accommodate all the necessary young stock for replacement in the herd, a further 80 acres of land has just been rented.

The herd is strictly rationed according to yield, and the feeling is that it certainly pays to feed good quality cakes. An experiment made upon two cows giving the same yields showed that cheap feeding stuffs are a false economy, for the yield of the animal receiving the poorer grade of cake soon began to fall away. A good deal of bran is fed to the heavier yielders. Cabbage is fed in considerable quantities in autumn and winter, after which mangolds and swedes are fed. The quantity of hay fed is also rationed. Nothing special is done to the hay crop beyond slugging and liming the fields.

It soon became evident, in respect to the policy of producing as great a quantity of milk as possible, that if Friesian cows gave on the average a higher yield than the cross-bred Shorthorns, the butter-fat percentage being satisfactory, it was only commonsense to change over to a Friesian herd. In this comparison of milk yields, it was not only the question of yield per cow per day, but the number of days in a given year during which the cows were in milk. From the official milk records kept on this farm for the year ended October 1, 1938, ten Friesian cows were in milk for an average of 286 days out of 365, while ten cross-bred Shorthorns were in milk for 253. In other words, the herd of ten Friesians gave 330

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days more milk in the year than the herd of ten cross-bred Shorthorns. This represents, on a basis of just over three gallons a day, a difference of a thousand gallons of milk a year, which at the round price of 1s. per gallon is worth £50. This sum may be regarded as clear profit, since the Friesian group takes no more food and labour than the Shorthorn group.

The small retail round which is now run in connexion with the farm provides evidence that the consumer is prejudiced against the "dead-white" appearance of milk from Friesians, and apparently no amount of argument that these cows are part of an attested herd and that the butter-fat is well above the legal minimum will persuade customers that a creamy colour in milk does not necessarily signify better quality. It is entirely on account of this attitude that a few Guernsey cows are kept. As a matter of fact, the official butter-fat tests of the Friesians in the herd show that, with one exception, the average percentage is over 3.5 and in some cases over 4.0 for the lactation. The one exception was a heavy-yielding cow whose averages for her last two lactations are 3.0 and 3.2 respectively.

As a means to further increased production it is intended to bring the flock of sheep up from the present 40 ewes to 80 or 90 and to increase the poultry from the present 400 to about 600 or 700, which appears to be almost as many as can be managed, when it is remembered that these have to be kept away from the cattle. The cattle are never allowed in a field that has been occupied by the fowls until an interval of about a month has elapsed, and this rule limits the number of hens it is possible to run on the land. It is intended also to increase the milking herd from the present 32 to about 40, which it is felt will be possible with the extra land now available. It is hoped, too, that it will be possible to rear more heifers than will be required for replacements, so that a selection can be made when they calve down, the best only being kept and the remainder sold.

FERTILIZER EFFICIENCY—PHOSPHATES

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The value of fertilizer treatment depends both on the immediate response and on the duration of the effect. On arable soils, particularly in the drier parts of the country, superphosphate is, in general, still considered to be the most effective phosphatic fertilizer in the year of application, especially for spring application and, though its phosphate is initially easily soluble in water, it does not wash out from the soil to any great extent. For this reason it is usually considered unnecessary, even on arable land, to apply phosphate every year, no matter what type of phosphatic fertilizer is used. Provided a reasonable dressing is given somewhere in the crop rotation, several succeeding crops are generally able to obtain sufficient phosphate presumably from the residues of the earlier dressing. After a few years without added phosphate, however, crops usually begin to suffer, and such evidence as is available suggests that this may often occur when a proportion of the original phosphate application is still unrecovered. In this connexion it must be remembered, however, that figures for percentage recovery must not be looked upon as necessarily final, for they will vary somewhat with the type of crop used in the assessment, since crops differ in their responsiveness to phosphate and in their ability to utilize different types of phosphate. For instance, swedes are more responsive than mangolds, whilst lupins and swedes can utilize mineral phosphate much more efficiently than cereals or potatoes.

On permanent grass land the recovery of added phosphate, whether basic slag, superphosphate or mineral phosphate, as measured by the increase in the amount of phosphate removed in the hay or by stock grazing the herbage, is also relatively low. On Tree Field at Cockle Park, out of a total application of 1,200 lb. of phosphoric acid per acre since 1897, applied in the form of triennial dressings of 5 cwt. per acre basic slag, the recorded liveweight increase of stock grazing the plots

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accounts for the recovery of only 7.7 per cent. of the added phosphate, whereas analysis shows 91 per cent. of the added phosphate still in the top nine inches of the soil. Despite this high reserve of phosphate in the top layers of soil, however, "at each new triennial application a marked change in the herbage is apparent" (see J. A. Hanley, *Report of 4th International Grassland Conference*, pp. 288-293). Again, on another plot receiving slag, on Hanging Leaves Field at Cockle Park, the recovery of phosphate is only 11.1 per cent. Why soils with such a high reserve of phosphate should respond so readily to further applications is still a matter for speculation, but it agrees with practical experience in so far that heavy applications of phosphate are often required to effect an initial improvement in the herbage of poor grass land, especially on soils very deficient in phosphate. Superphosphate on Tree Field at Cockle Park does not show quite as great an accumulation of phosphate in the soil as does basic slag, but, nevertheless, the accumulation is considerable in comparison with soil receiving no phosphate, and the percentage recovery is no greater than with basic slag. In other experiments, reported by E. M. Crowther in the *Journal of the R.A.S.E.*, 1934, approximately one-third of the phosphate added in the form of slag or superphosphate was recovered in the herbage under a system of monthly cuts, but the percentage was smaller where hay crops were taken, even considering the total recovery over a period of three or four years, and this despite marked increases in yield and in the phosphate content of the herbage at several centres. The recovery from ground mineral phosphate was similar to that from slag and superphosphate on acid soils, but considerably less on neutral soils.

It is therefore evident that a large proportion of the phosphate added to soils is converted into forms of varying availability, and further investigation shows that the method and the extent of the conversion differs with soil and environmental conditions. The matter is of great practical importance, since this locking up of phosphate means that fertilizer applications must supply larger amounts than are actually required by the crops, particularly on soils initially very deficient in phosphates. In this connexion the relatively high proportion of phosphoric acid to nitrogen and potash used in artificial fertilizers, as compared with estimates of the relative amounts removed in various crops, is interesting,

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since these show that, whilst most crops remove at least twice as much nitrogen as phosphoric acid, the consumption of phosphoric acid in the form of artificial fertilizer is some $2\frac{1}{2}$ times the consumption of nitrogen. There are, of course, numerous other sources from which crops obtain nitrogen, and it is not safe to argue directly from the composition of crops to their fertilizer requirements; nevertheless, the discrepancy does seem very considerable.

Research work is in progress into the fate of phosphates when applied to a soil, into the forms in which phosphate is present in soils and into the uptake of phosphate by crops. These three problems have an important bearing on the subject and are worthy of consideration at this stage.

That added phosphate combines with or is fixed fairly quickly in some way by the soil is shown by the analysis of different horizons of the soil profile. In a report on the phosphate content of Swedish soils, O. Franck points out that on arable soils the phosphate content of the top soil (i.e., the ploughed layer) is, as a rule, higher than that of the sub-soil, the limits, generally speaking, being sharply defined. In pasture soils, where there is little or no mixing of soil and fertilizer by the action of implements, the condition is even more marked, the content of phosphoric acid being particularly high in the top one or two inches. The difference in the distribution of phosphate in arable and pasture soils is attributed to the very limited solubility of phosphate in the soil moisture. Hence the possible importance of placing the fertilizer in the correct layer in the soil. Franck states that, on conversion of an arable field to permanent grass, the sharp differentiation of phosphate content at the former ploughing depth soon disappears and the soil shows a material increase in the phosphate content of the upper layers. Franck calls this the "degeneration" of the soil, as he contends that such concentration of available phosphate in the surface layers might favour the growth of shallow-rooted pasture plants, thereby reducing resistance to drought. The way in which this fixation of phosphate is brought about, and the chemical forms in which phosphate is generally present in the soil, have been studied both in the laboratory and in pot culture experiments. In general, the laboratory work has shown that the power of a soil to fix phosphate appears to vary with the amount supplied—the heavier the dressings the less firmly is it held. It is generally agreed, however, that there are at least three main

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groups of phosphate compounds in the soil, and the particular form in which added phosphate is fixed will depend largely on the soil itself, especially on its clay content and on its degree of acidity. For instance, in neutral or nearly neutral soils much phosphate is likely to be fixed in combination with calcium; if there is a large excess of calcium present the compound is likely to be less available than in a soil with little or no excess of calcium. In an acid soil, on the other hand, fixation takes place largely in combination with iron and aluminium compounds, forming iron and aluminium phosphates of very low availability, the phosphate being too firmly held to be easily recoverable by crops. It should be noted here, however, that the addition of lime to an acid soil usually increases the amount of easily soluble phosphate. In addition to these inorganic compounds, organic compounds of phosphorus also occur in the soil, whilst it is probable that phosphate may also occur in other forms in the clay complex.

These laboratory results are supported by results of pot culture and field experiments. In America, pot culture experiments have shown that different types of soil when mixed with sand may exert very different effects on the response to superphosphate as compared with the response in sand alone. The differences in these experiments appeared to be associated with the composition of the clay particles in the soils and suggest that some of the soil constituents, particularly the clay fraction, may take up the added phosphate, rendering it unavailable to the crop, if they are not already "saturated" with phosphoric acid. The danger of this is, of course, greater in a clay than in a sandy soil. With such soils it was found in pot cultures that superphosphate was more efficient when placed in a thin layer below the seed than when uniformly distributed throughout the soil-sand mixture.* It has also been suggested that the use of superphosphate in a granulated form might reduce the rate of "fixation" of the phosphate.

This, of course, opens up the now familiar topic of where is the best place to put the fertilizer in relation to the seed or plant, and the question of the relative merits of granular and non-granular fertilizers of the same analysis. The possibilities of both these methods of reducing phosphate fixation are being fully explored, especially in America, whilst results

* P. L. Gile, *U.S. Dept. Agric. Tech. Bull.*, No. 371; July, 1933.

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of trials in Sweden have recently been published. American workers point out that, though it has been proved by experiment that such substances as limestone, mineral phosphate and other similar materials are more effective when applied as a finely ground powder, there is an important difference between them and such fertilizers as superphosphate, the difference being, of course, their low solubility. Insoluble fertilizers require to be finely ground so that they may be less resistant to the solvent action of the soil solution and the plant roots, but soluble fertilizers require to be maintained in a soluble form if they are to remain readily available to plants. Increasing the size of fertilizer "particles" by granulation, or concentration of the fertilizer in "bands," may perhaps reduce the surface exposed to fixation by the soil, and it has been suggested that such devices may permit a larger proportion of the soluble fertilizer to remain in a readily available form for a longer period. Particular attention has been paid to granulation and placement in bands in those parts of the U.S.A. where soils are known to be far from saturated with phosphate and on which therefore little or no response can be obtained from small applications of phosphate.

In Sweden (*Bulletin* 483, *Swedish Central Experiment Station*) Franck states that the development and appearance of the root systems of barley and oats are much affected by the manner in which the phosphate is spread. Root hairs develop strongly in those layers of soil to which superphosphate is added and, where granular superphosphate is used, the roots are closely knitted round the granules which constitute relatively constant sources of phosphate. The granular product in both pot and field trials was said to show a greater effect than the ordinary powdered material, whilst working the fertilizer deeply into the soil, as opposed to lightly harrowing in, gave better results with both powdered and granular products. On acid clay soil low in available phosphate, yields were improved by liming as well as by applying phosphate, but the effect of lime was held to be due to a liberation of available phosphate, showing that, on such soils, the phosphate content is a question not of manuring alone but of manuring and liming.

The complementary effects of lime and phosphate on the uptake of phosphate on an acid soil are also shown by the results of experiments on acidic upland soils in Wales,

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described by R. O. Davies and W. E. J. Milton in the *Empire Journal of Experimental Agriculture*, January, 1939. Over a period of seven years the total recovery of phosphate obtained in the herbage removed from one area amounted to 19.5 per cent. of that applied as manure (in the form of 12 cwt. per acre basic slag at the commencement of this experiment), compared with 18.1 per cent. recovered in another area. The inclusion of ground limestone in the manurial treatment raised the recovery of phosphate to 30.2 per cent. in the one area and to 24.2 per cent. in the other. The question of the efficiency of phosphatic fertilizers is still obscure in many ways, but certain points stand out fairly clearly. There is a definite tendency for phosphatic fertilizers to become fixed in the soil so that their subsequent movement in the soil moisture is very restricted. The firmness with which they are fixed depends on a variety of circumstances, many of which are beyond the control of the farmer. One of the most important factors in determining the firmness of fixation, however, is the acidity of the soil. On neutral or nearly neutral soils, fixation is likely to take place to form a calcium phosphate which will be more available subsequently than the iron and aluminium phosphates formed in acid soils. Hence lime and phosphate are complementary to one another; not only will an application of lime increase the available phosphorus in an acid soil, but, by maintaining the soil in a condition somewhere near neutral, lime will prevent the formation of the more insoluble and unavailable forms of phosphate. In the presence of excessive amounts of calcium a less available form of phosphate is likely to be formed than in soils with no large excess. Though it is not likely that lime will be applied in such large doses as to make this a serious factor in general practice, this condition obviously may arise on chalky soils. Other ways in which it may eventually be found possible to increase the efficiency of phosphate applications, to arable soils in particular, appear to be by distribution in such a manner as to limit the surface exposed to the action of the soil, e.g., by concentration in bands or by granulation and, especially in soils with a high fixing power such as phosphate deficient heavy soils in which movement of phosphate in the soil moisture is at a minimum, by placing the fertilizer at that depth in the soil at which roots can make best use of it. So far there is very little evidence as to the merits of these devices under the conditions prevalent in this

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country, and even if, by the adoption of either method, it is found possible to reduce the application to the particular crop in the rotation to which phosphate is applied, it will still be a matter for investigation to see whether the residues from the smaller dressing are adequate for subsequent crops, or whether the smaller dressings must be applied more frequently, and if so, whether the increased efficiency in the action of the fertilizer is sufficient to cover the extra cost of distribution.

The accumulation of phosphate in the upper layers of soil on old permanent grass land receiving regular doses of phosphatic fertilizer presents other problems of which the possibility of releasing the reserve and the prevention of such excessive fixation in the future, are two of immediate practical importance. Space does not permit further consideration of these and other relevant problems in this article, but it seems possible that resort to the plough occasionally may prove to be the most effective remedy.

CATTLE REARING*

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Introductory. The importance of live stock in British farming is well illustrated by the following Table, which shows the estimated values of different products sold off the land in 1908 and in 1936:—

TABLE I.—ESTIMATED VALUE OF PRODUCE SOLD OFF FARMS OR CONSUMED IN FARM HOUSEHOLDS IN GREAT BRITAIN

	1908† Thousands £	1936* Thousands £
Cattle and Calves	61,400	35,870
Sheep and Lambs		20,740
Pigs		24,240
Milk and Dairy Produce	30,000	64,480
Poultry and Eggs	5,000	25,070
Wool	2,000	2,690
TOTAL LIVE STOCK AND PRODUCTS ..	99,000	173,090
Total Farm Crops	46,600	42,810
Fruit, Vegetable and Glasshouse Produce	5,200†	30,140
GRAND TOTAL	150,800	246,040

‡ Agricultural Output of Great Britain, Cd. 6,277.

* Compiled from Agricultural Statistics of the Ministry of Agriculture and the Department of Agriculture for Scotland.

† Including timber.

The figures show that, of every £10 which the farmer now receives, about £7 is derived from the sale of live stock and only £3 from the sale of crops. Allowances must be made for the facts that large numbers of cattle, partly matured, are imported from Ireland, that straw, roots and other products of arable farming are fed to stock, and that increased importations of grain and other foods from overseas must be set against the great increase in the production of milk and eggs since 1908. Even if full weight is given to these considerations, it will generally be admitted that the livestock industry is the most important branch of British farming.

* This is the first of a short series of articles by Professor White on "British Systems of Stock Farming."

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It would, however, be a mistake to regard it as a single unit. It is rather a group of industries, each developed and maintained under certain conditions of climate, soil and accessibility. One object of this series of articles will be to demonstrate the way in which various systems have been adapted to special conditions in much the same way as rotations of crops are modified to suit local circumstances. Apart from the obvious sub-divisions of the industry according to the kind of stock—cattle, sheep, etc.—different types, breeds and ages of each are selected for special conditions. Thus certain districts are devoted to the rearing of young stock, cattle or sheep, or both; others specialize in the fattening of stores obtained from the rearing districts; others import breeding stock and concentrate on dairying or fat lamb production. Partly for this reason, Table I has been compiled for Great Britain as a whole. Movements of stores and breeding stock, particularly of sheep, from Scotland to England take place on such a scale that consideration of one part of Britain alone may be misleading. Indeed, all the British Isles might well be considered as a unit from a stock point of view, because both Scotland and England import large numbers of store cattle as well as some store pigs and sheep from both parts of Ireland. For instance, in 1936 Great Britain received from Ireland 570,000 store cattle and 70,000 dairy cows, whilst of 964,000 bullocks, heifers and cow heifers certified under the Fat Cattle Subsidy Scheme in the eight months August, 1937, to March, 1938, in Great Britain 268,000 were imported—practically all from Ireland. Though on a very much smaller scale, the importation of dairy cattle from the Channel Islands is also worthy of notice.

Of the different kinds of live stock, cattle are much the most important, so that systems of cattle management will be dealt with first.

Cattle Rearing. Cattle are reared under a great variety of systems in almost all parts of the country, but the typical rearing district is one in which there is a large proportion of second-rate grass land. Much of this land, though unsuited for fattening, or for producing large quantities of milk, is capable of producing well-grown stores, and; by using it for this purpose, the better and more expensive land can be reserved for the final fattening process or for intensive dairying. Circumstances may induce a farmer on good land

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to rear a considerable proportion of his stores, but that is exceptional and the national economy is well served by the usual division into rearing and fattening land. It is wasteful to use good grass for rearing, when a satisfactory animal can be raised on pasture of much poorer quality.

Western districts, with their high rainfall, mild winters and long growing seasons, as well as their large area of upland or second-rate grass, are the areas in which most cattle are reared. These include Ireland, the South-West of England, Wales, and North-West of England and the South-West of Scotland. The well-defined movements of stores in spring to grazing districts for summer fattening, and in autumn to arable districts for winter fattening, mainly consist of stock drawn from one or other of the districts mentioned.

The trade in heifers and cows for dairy purposes is rather different from that in cattle for fattening purposes as the majority of dairy farmers rear some of their own heifers. But, even so, there is a large movement of heifers and cows from the rearing districts, particularly of the West (including Ireland) and North-West (including the South-West of Scotland) to dairy farms in various parts of England and Scotland

TABLE II.—NUMBER OF BULLS LICENSED

	England and Wales, 1937-38	Scotland, 1937
Shorthorns	23,730	1,491
Lincoln Red Shorthorns	1,324	2
British Friesians	2,671	234
Herefords	2,110	—
Guernseys	1,924	16
Devons	1,091	1
Aberdeen Angus	755	1,657
Red Polls	569	7
Jerseys	545	17
Ayrshires	489	4,808
South Devons	439	—
Welsh Blacks	349	—
Galloways	248	272
Sussex	235	—
Other Breeds and Crosses	200	80

COMPOSITION OF CATTLE POPULATION. In forming a picture of the cattle industry it would be very useful to have accurate figures of the numbers of different breeds. In the absence

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of such a census, the number of bulls of the different breeds licensed may be taken as a rough indication of relative numerical importance. When studying such a table, it should be remembered that not many bullocks of the dairy breeds are reared and that a good many bulls of the beef breeds are kept mainly for crossing purposes, so that in both these instances, calculations based on numbers of bulls may give too high a figure.

METHODS OF REARING. In most beef breeds, the cows simply suckle their own calves, and in this way many of the best store cattle in the country are reared. The usual plan is for the cows to calve in the early spring, so that full advantage is taken of the grazing season, and by autumn the cow is practically dry and the calf is weaned. The sole return for the keep of the cow for the full year is thus the weaned calf in autumn. On the other hand, there is little expenditure on labour or purchased feeding stuffs, and, if a sufficient area of suitable grass land is available at a cheap rate, the system may prove fairly remunerative. Sometimes, with a hardy breed like the Galloway, the cost of the keep of the cow on rough hill pasture may be regarded as nil because of the improvement which grazing by cattle effects on certain types of such land. Often, however, the cost of wintering the cows takes a large slice out of the receipts, and accounts for the tendency to change to other systems which bring in a bigger return.

The return for keeping a cow for a year under this system, however, is low unless the calf for some reason is of specially high value. Consequently, it is not suited for the production of commercial stores on a small farm, where, at best, only a limited number of cattle can be kept. While, therefore, the system is still extensively practised—as indicated by the numbers of the beef breeds which are generally reared in this way—the small farmers, who form the vast majority of cattle rearers, cannot afford to follow it, and have to adopt a system which gives a greater return for a given area of land.

Until recent years, the system almost invariably followed was that of combining the rearing of store cattle with the sale of butter, and this is still the most common method. The cows are milked by hand; calves receive whole milk for the first month or two, and afterwards have skim milk, together with some cream substitute. As a rule, more than one calf

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is reared in this way per cow, and though the calves at six months old do not compare in condition with suckled calves, they are still capable of growing into high-class stores if properly bred and suitably managed.

It is largely because this is the most common method of rearing, and because of the desire to produce store bullocks for fattening, as well as heifers to take their place in the dairy herds, that the vast majority of cattle in England and Wales are of dual-purpose type, as shown in Table II. Shorthorns outnumber all other breeds put together, and, though they include many of extreme beef and dairy types, there can be no doubt that the great majority are of dual-purpose type. If to these are added the other dual-purpose breeds, including Lincoln Reds, Red Polls, South Devons and Welsh Blacks, the great preponderance of dual-purpose cattle in the country is obvious, so that, in considering rearing methods, we have to think mainly of herds of dual purpose character.

Not only is the typical rearing farm in a western region usually of rather low fertility, but it is also remote from big centres of population, so that the sale of milk is attended with difficulty; it is comparatively small, and most of the work is done by the farmer and his family. It may be entirely of grass, but, more often, includes a certain area of land under the plough with long leys instead of permanent pasture. This is partly to provide food for the cattle during the winter, partly in recognition of the value of the plough in renewing the productivity of the grass land and its suitability for young stock. In the last few years, some farms of this type have come within the ever-widening range of the milk-collecting lorry from some town or milk factory, but, even now, on very large numbers of farms, a good well-bred calf provides the best available outlet for the milk, and butter is produced as a by-product. Where milk is sold to a factory, separated milk is often returned to the farm, so that calf-rearing is still a very important activity. The calf born in winter or early spring will go out to grass from June to September, and will be kept indoors during its first winter. Very often it will then be sold at about a year old to some larger neighbouring farmer who has a considerable quantity of second-rate pasture, on which the yearlings can be cheaply kept in a good growing condition. The farmer may sell again in autumn, or, if well provided with winter keep, may retain the stores until the following spring. If sold in autumn, they may go direct to

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an arable district for winter fattening, or may be cheaply wintered on some other farm for resale as forward stores to a grazier in the following spring. These transfers and sales, with their consequent expenses and checks to the progress of the animal, have obvious disadvantages. There is real need for a better organization of the trade, so that animals may pass as directly as possible from one type of farm to the other without passing through the hands of several dealers or being exposed in a number of sales. At the same time, the movements cannot be reduced beyond a certain minimum if the suitability of different types of land for different kinds of stock is to be fully utilized.

RETURNS FROM REARING. *Changing Systems.* Opinions will naturally be sharply divided regarding the fair allocation of the value of the finished animal between the rearer and the feeder. The position of the latter will be considered in future articles, but, however he has fared, there can be no doubt that the rearing of stores for fattening for some years prior to 1938 did not give a satisfactory return. For this reason there has been a strong tendency to take up other systems. The rearing of stores is in the main carried out on small farms by family labour, and, at best, it is to be feared that the farmer's wife and family receive a very low financial return for the labour and attention they bestow on the calves and young stock.

It happened that a period of very low prices for stores occurred about the time that the Milk Marketing Scheme came into operation, and the chance of selling milk was seized by large numbers of rearing farmers as a means of securing a better and more assured income. This change has had far-reaching effects on systems of management and types of stock. Sometimes, new breeds of dairy types have been introduced, and, even where the dual-purpose breed has been retained, the bias has been towards dairy qualities even if it involves considerable sacrifice of beef characters. The result has undoubtedly been a deterioration in the quality of stores from a feeder's point of view, partly because of changed standards of breeding and partly because of poorer rearing.

It is impossible to blame the rearer for this change as he has to think first and foremost of his own interests. He may not obtain so much for his bullocks, but he will obtain a good price for surplus heifers or cows, and, in addition, he has a steady return for the sale of milk.

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REARING IN OTHER DISTRICTS. The difficulty of securing the right class of stores has led to more rearing being done outside the typical rearing districts, and this tendency has been encouraged by the large increase in the area of grass for which some cattle stock is required.

Where this happens, the system most favoured is to suckle calves on dairy cows—often animals which have been taken out of good herds for some defect. Such a cow will often give enough milk for three calves, which she rears for 8 or 10 weeks, during which time they are encouraged to taking concentrated dry food. They are then weaned and replaced with 2 or 3 more calves. In this way a good cow will suckle as many as ten calves in a year and three or four are very commonly reared on an ordinary cow.

Need for Organization of Trade in Calves for Rearing.

Except in the comparatively few instances where cows of beef breed simply suckle their own calves, rearer farmers in rearing districts usually wish to rear more than one calf for each cow in the herd. This raises one of the chief difficulties of the system as they often find it very difficult to obtain a regular supply of the class of calf they would like to have. On the other hand, many dairy farmers who keep a good dual-purpose type of cow rear hardly any calves, and they usually sell the calves at a few days old for a very low price. An arrangement whereby the dairy farmers would keep good beef bulls and the rearers would contract to take the calves, would be of great benefit to both and would, at the same time, ensure a better supply of good stores for the feeder.

SHEEP RUGGING IN AUSTRALIA

W. F. McQUIN,

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The extension to the entire flock of the practice of rugging or covering stud sheep and sheep for exhibition purposes may seem at first glance to be a very revolutionary change in practical sheep-farming methods, but extensive and comprehensive trials in the three main sheep-producing States in Australia, namely, South Australia, Victoria and New South Wales, have proved that, far from being impractical, the general application of these new methods not only is eminently practicable but also is accompanied by higher cash returns to the grower applying them. The commercial rugging of flock sheep in Australia has now come to stay and is rapidly gaining the confidence of the sheep growers. This practice has passed far beyond the preliminary experimental stages, and the various State Agriculture Departments are now carrying out trials at Government Research Stations to determine by scientific methods the quantitative and qualitative effects on wool and mutton production.

The rugs themselves present no insuperable obstacle. Although covers can easily be made from corn sacks, etc., it has been found in practice that where large numbers of rugs are required—one prominent Australian grower rugged 7,500 ewes last season—it is infinitely cheaper and quicker to obtain commercially-made sheep rugs already on the market. Not only are these rugs more durable—some of them will last for three and even four seasons—but also they are easy of adjustment to fast-growing fleeces. Waterproof material is not necessary as the natural grease in the wool saturates the rug and produces the same effect.

The expenditure in time and labour is actually relatively small. An official test in New South Wales showed that two unpractised men could rug approximately 100 sheep per hour. Depreciation due to very badly torn rugs is as low as 2½ per cent. Repair and maintenance is also a small item and the replacing of torn rugs, if any, can be very simply and expeditiously

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accomplished by carrying one or two spare rugs when making the daily round of the sheep and replacing them in the paddock. When flock rugging was first introduced in South Australia, the theory that the greatest advantage would accrue by rugging for the full season was most generally held, but, like most theories, this was modified by subsequent practice. There is no doubt that rugging from shearing to shearing may be most beneficial in some districts, namely, those in which grazing conditions are very dusty all the year round and in which winter conditions are very severe, but, as a rule, it has been found that a period of 4-6 months is the most satisfactory, and this view is now held by the generality of Australian growers. Further, this shortened period prolongs the life of the rug to a very appreciable extent.

One of the main advantages of a rug is the elimination of that long wasty tip so apparent in some wools, and hence it is advisable to rug as soon after shearing as practicable. In Australia, it is usual to rug after dipping, which takes place usually about a month after shearing, but although a very small tip may have made its appearance it is often impracticable to place the rug on directly after shearing and then remove it prior to dipping.

The primary functions of a rug are to protect the animal from damp and cold and also to keep dirt, etc., out of the fleece as there is little demand for dirty wool, and anyone who has travelled or yarded sheep is aware that there is always a thin film of dust lying over them. Another important factor in lowering the value of good wool is the presence of bidi bidi or burr and thistle, etc., in the fleece, which is avoided when the sheep are rugged.

The first aspect considered by most sheep growers as regards rugging is the probable effect on the wool output. From the point of view of increased quantity and improved quality of wool yield, however, rugging has proved itself repeatedly to be a sound economic proposition. In a very large number of experiments in South Australia the increase in wool value alone has varied between 1s. 11½d. and 6s. 8d. per head. From these values, of course, the initial cost of the rug must be deducted, but when it is realized that the average commercially-made rug will last for three and even four seasons it can be seen what an enormous increase this is. In fact, the cost of the rug is repaid by the increase in wool returns alone in the first season.

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Although, as has been mentioned previously, rugging of flock sheep was introduced primarily to prevent dirt, etc., from penetrating the fleece, it has been proved in practice to be of even greater advantage in fattening. It can be readily understood, therefore, that the added fattening properties of rugging mean a higher carrying capacity, as lambs and stores, etc., can be sent away sooner and thus make room for more sheep. For example, at the abattoirs saleyards in Adelaide a draft of Shropshire lambs which had been rugged for nine weeks made 30s. 7d. per head, while a like number from the same flock and which had not been rugged brought 27s. 10d. The dressed weight of the rugged lambs averaged 55 lb. as against 47 lb. for the unrugged. As the lambs selected for this experiment were of even weights at the commencement, there was an increase of nearly 1 lb. per head per week in the weights through rugging. A later offering of rugged lambs at the same saleyards made 21s. 10d. and topped the market, while unrugged lambs from the same flock made only 17s. 1d.

Further, rugged sheep invariably come through a hard season in better condition than those which have not been rugged. A concrete instance of this aspect comes from New South Wales, where, during the recent severe drought, one grower sent away as fats a draft of aged store ewes which had been rugged throughout the season, while the remainder of the flock, which had not been rugged, had to be hand-fed on maize.

Apart from the increased monetary return in the shape of larger wool and lamb cheques, the grower derives certain other benefits which, though they might not be measured in actual terms of £ s. d., are none the less in direct relationship to his pocket. For instance, it has been proved that rugged sheep are not as susceptible to fly strike as the unrugged and in one flock of 656 rising 2-year-old rams, where 136 were rugged, only one of the rugged was struck whereas in the unrugged group fly strike was as high as 25 per cent. Although it has been stated that maggots relish the protection of a rug, it remains that very rarely do the flies ever get under the rugs.

It follows as a natural corollary to the protection from cold afforded by rugging, and the consequent maintenance of body heat, that much of the food energy consumed by the animal can be directed to other purposes, resulting *inter alia* in greater wool production, maintenance of body weight, a higher

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percentage of better lambs and a greater capacity for resisting diseases and parasites.

The evidence available goes to show that lambs from rugged ewes are bigger, are generally in better condition at birth and do better than lambs from unrugged ewes running in the same flock. Moreover, rugged ewes can be mated, allowed to lamb and yarded without any special attention. Several Australian growers are now rugging their ewes purely as an aid to better lambing percentages, and one grower is rugging his old ewes so that he can get another lamb drop from them.

It is elementary knowledge that sheep do not evaporate moisture through the pores of the skin but through the mouth only, so that they are not inconvenienced by rugs in hot weather. On the contrary, in very hot temperatures it has been shown that the body temperature of rugged sheep is several degrees lower than that of unrugged.

These results have been obtained in a country subject to high temperatures and dry conditions, a country where the fine-woolled Merino is predominant, and it is the considered opinion of men competent to judge that even greater benefits would accrue in a country with higher rainfall and more rigorous winter conditions, and where a coarser woolled sheep is preferred. Cross-bred and shorter woolled sheep appear to respond more quickly to the treatment of rugging than the fine-wool Merino.

SPRING CABBAGE

R. C. GAUT,

Agricultural Organizer for Worcestershire

Spring cabbage is an outstanding example of a crop that has increased remarkably in acreage since the middle of the nineteenth century. Owing to its bulky nature, its market value formerly depended upon the road mileage separating producer from consumer, but after railways had linked country with town, in some measure annihilating distance, transport problems became less important. Despite this, production from 1850 to 1880 moved only slowly upwards. Market-gardening and agriculture were still widely separated industries, and the farmer had little interest in growing vegetables, potatoes excepted, to sell for human consumption; he lacked both the knowledge and the inclination.

Since 1880, however, and more particularly during the last 20 years, large numbers of farmers have been cultivating increased acreages of fruit and vegetables; in fact, agriculture and market-gardening have become so intimately merged in some areas as to defy classification of holdings.

Soils and Aspect. Heavy soils are not suited to spring cabbage. Excessive moisture in the winter months is fatal; quick drainage after rain is necessary. Deep alluvial land, sandy loams and loams provide the best conditions. Natural drainage is one of the essential factors; in places where rain water collects in depressions and disappears slowly, the grower's obvious remedy is to break up the pan, 10-12 in. below the surface, with a sub-soiling implement.

Soils tending to pack cannot be hoed early enough at the turn of the year; a shallow, dry crust forms while the next few inches are still wet. Ability to drain rapidly is a most important soil character, because the earlier in the new year the hoe can be started the sooner will the plants begin to move; a difference of only 24 hours at this period is significant.

High-lying, wind-swept land will not grow early cabbages; relative altitude also affects earliness. Maturing as they are

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expected to do in March, April and the first week in May, southern gradients sheltered on the northern and eastern sides are the most congenial situations. Growth at this time of year is especially aided by sunny days; falling night temperatures coincident with heavy dews promote leaf development. These conditions are to be found in the vales where fruit blossom is notoriously liable to damage from spring frosts.

Weather. Adverse weather between July and April causes the cultivator much concern. His troubles begin at seed sowing; drought hinders germination, and the plants appear irregularly or in insufficient quantity; or an attack of flea-beetle may have to be combated with derris or other insecticidal sprays. On the other hand, warm, moist weather brings the seedlings on too quickly and in advance of the planting season.

Dry weather delays planting, and even if the work proceeds according to plan, the autumn months have still to be encountered. When unusually warm and moist, the crop grows so rapidly that a considerable proportion is almost ready to cut before Christmas. The intervention of hard frosts in December after a warm autumn such as were experienced in 1938, has severe effects on a forward crop, extensively damaging the major part; the unfolded succulent leaves turn white and the heart begins to rot.

Low soil moisture towards the end of winter and beginning of spring, at a time when free growth should be conspicuously in evidence, retards and even inhibits leaf development; this happened in 1938. The specialist rather welcomes, in fact he hopes for, east winds in March, not too violent or "biting," but sufficiently keen to discolour the ill-nourished plants. Stamina, induced by reasonable shelter, inherent soil fertility and adequate manuring, means much under such conditions; as soon as the weather changes the plants make rapid headway.

Position in Rotation. Although strict rotational planning is incompatible with market-gardening, the catch-crop spring cabbage, if cleared early, fits in quite well with certain vegetables that are grown on a large scale. The Worcestershire custom of long standing is to follow brussels sprouts with peas or dwarf beans, both of which are disposed of early.

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Runner beans are also grown; if the remnants are sacrificed, there is still time to prepare the land for later planting of spring cabbage.

Another succession is brussels sprouts, cauliflower, spring cabbage—three members of the Brassica tribe. Although departing from the recognized principles of rotations, there are instances where this practice appears to be justified. Under any of these arrangements the land carries three crops in two years.

Manuring. GENERAL CONSIDERATIONS. On well managed mixed farms, where the acreage of arable to grass land is proportionate, farmyard manure continues to have an important share in maintaining the fertility of cultivated fields. Temporary leys (clovers, or grasses and clovers) are sown with regular frequency; the residues, when ploughed under, add further quantities of humus to the soil, augmenting the plant food and improving the texture.

Typical market-gardening presents an entirely different problem. Practically everything is carted off the land, and except for the scanty trimmings of crops the amount of humus-forming material left behind is almost negligible. Cultivations are much more thorough, and on the lighter types of soil humus not only disappears rapidly but does not accumulate to any extent. In one controlled experiment, after five complete rotations—brussels sprouts, peas or beans, spring cabbage—the amount of organic matter in the soil of two plots, dressed five times in ten years with farmyard manure at the rate of 20 tons per acre, was only slightly increased.

Evesham gardeners used to make annual contracts for stable manure from the urban centres, but mechanized transport has almost extinguished the supply. Mineral fertilizers have been freely used as substitutes, and for a time crops have done well, but weight and quality have dwindled by degrees. Inorganic fertilizers failed to maintain the high state of soil fertility that intensive cultivation demanded, and manurial planning had to be modified.

Intensive market-gardening is a different proposition from vegetable-growing on farms and has to be treated as such. Expensive organic manures have to be purchased to maintain soil condition and minerals used supplementary thereto. Especially does this apply to the lighter soils.

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METHODS IN PRACTICE. Where the ordinary succession of cropping is pursued, spring cabbage is regarded as the first crop of the short rotation; the land is generously manured. Little or no scientific information exists as to the compositions or quantities of fertilizers required for an acre of land; each grower backs his own judgment, relying upon the results of long experience.

Organic fertilizers are selected from shoddy, crushed hoof, fish manure, meat and bone. The utility of shoddy is governed by its mechanical state, together with the nitrogen content; clippings, or "wool nips," are preferred to the lumpy forms and ploughed in at the rate of 2 tons per acre. Crushed hoof, fish manure, meat and bone, are worked into the surface soil after ploughing and immediately before planting. With these, according to the amounts given per acre, superphosphate or bone meal are sometimes used, and potash, mostly sulphate of potash, always. Latterly, there has been a tendency to omit direct additions of phosphates, market-garden soils being generally high in this constituent, and to increase the potash; plants undoubtedly winter better.

Hard and fast recommendations for manuring prior to planting are not possible owing to the absence of conclusive information. From the long-term rotation experiment at the County Experimental Station the following can be confidently advised for light to medium land in a reasonably good state of fertility:—

	<i>Per Acre</i>
(1) Fish manure	20 cwt.
Sulphate of potash	3 "
(2) Crushed hoof	15 "
Sulphate of potash	3 "

Compared with the foregoing, meat and bone has not given comparable crops, neither has shoddy shown any superior merit. Farmyard manure, ploughed in at the rate of 20 tons per acre, has proved inferior to purchased organic fertilizers for early cutting; delayed action rules it out for this purpose. Many Evesham growers consider 3 cwt. per acre of sulphate of potash too meagre and prefer to increase the amount by a further 2 cwt.

Mineral nitrogen at this period must be excluded; evidence upon this point is conclusive. It induces an autumn growth entirely undesirable in character and quite different from that shown by plants deriving nitrogen from an organic source.

The notion that friable organic manures are slow acting

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is an exploded fallacy; moreover, it is opposed to scientific reasoning. Harrowed into warm soil in August or early September the conditions are ripe for starting the breaking down processes, as reflected in the behaviour of the plants during succeeding weeks. Growth is steady but not stimulated; stamina is acquired, which implies resistance to winter weather ahead.

Although not strictly a fertilizer, lime must not be overlooked. High manuring and the complete removal from the land of large crops involve corresponding heavy losses of carbonate of lime which must be replaced if serious consequences are to be averted. Light soils are apt to become quickly depleted. Ground carbonate of lime, 1 ton per acre, is tending to replace forms previously used.

Seed Sowing. For early cutting, seed must be sown in good time. The Worcestershire custom, which is in advance of some other districts by three or four weeks, is to make two sowings—in the first days of July, and about July 12.

In moist seasons, first sowings are liable to get too forward. Conversely, if very dry, hot weather follows germination, the plants may become "hard in the seedbed"—a condition equivalent to a "hide-bound" fruit tree—and are quite useless.

Overhead irrigation, which a few growers happily situated near the Avon have been able to instal, does away with the need for the earlier sowing; further, the rate of seedbed production can be forecast with certainty.

The amount of seed to provide for one acre of plants is about 1 lb., sown in drills on a square chain of clean land; this gives a good margin for plant selection.

Some farmers sow about 4 lb. of seed per acre in permanent drills for producing small early greens. This system is not practised by market-gardeners.

Planting and After-treatment. Planting commences early in September, continues throughout the month and into October, spreading the work and giving a succession for cutting. "A cabbage cannot be too large and a cauliflower too small," is a popular phrase illustrating the comparative sizes of the young plants selected. "First pull" plants are the best.

Distances of 20 in. between rows and 10 in. between plants

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are varied slightly; the number required per acre may be more or less than 31,360. Close spacing, if the soil is in good heart, has obvious advantages; the individual plants afford each other shelter from cold winds and there should be more produce to cut. Rows 20 in. apart admit of horse-hoeing, though expert growers prefer all subsequent work to be done by hand labour only.

In the Vale of Evesham, one large farmer has mechanized the whole process of management; the cabbage are set by machine and all after-cultivations are performed by a mechanical horse-hoe which stirs the soil simultaneously between both plants and rows. Wider planting distances both ways are necessary.

At the first opportunity in the new year further manuring is anticipated and the hoe is again set to work. Until Peruvian guano became difficult to obtain, this, at 4-5 cwt. per acre, was the most favoured first top-dressing in January, especially for backward crops. The arrival of a cargo was eagerly awaited and excited competition among prospective buyers. Fish manure, at the same rate per acre, has now taken its place; most growers, however, use only mineral nitrogen for top-dressing. More recently, high grade potassic nitrate of soda, has found considerable favour on account of the deep-green colour it imparts to the leaves; a single top-dressing of 2½-3 cwt. per acre in February may suffice, but if the market promises well and the plants are backward and lack colour a second top-dressing is given, making a total of about 5 cwt. per acre. Whether applied in February, March, or early April depends upon the season and sale prospects. Each top-dressing, whether of fish manure, potassic nitrate of soda, nitrate of soda, nitrate of lime, or nitrochalk, is hoed in.

Cutting and Marketing. It is never possible to forecast the time of cutting long in advance. Last December spring cabbage trickled to the market in the autumn, before winter had officially commenced. Frost, snow, and the low price of brussels sprouts just prior to Christmas, restricted consignments which might have been very considerable. Early in the new year, the flow recommenced and continued steadily.

Reversed conditions prevailed in the autumn and winter of 1928-29. Numerous frosts occurred in all the months from

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September to January. On February 9 a frosty period set in, lasting until March 11—31 days—completely destructive to radishes, Seville beans and broccoli. Spring cabbage was crippled or retarded and very little reached the market before the first week in April.

The "pot" hamper, reputed net weight 40 lb., is still a common container. The non-returnable crate of similar cubic capacity, costing from 5*d.* to 6*d.* meets with approval if warranted by the sale value of its contents. Growers naturally reject it when prices are low, and it is certainly not a commercial proposition when spring cabbage is selling at 1*s.* per pot gross, as not infrequently happens during gluts, and when broccoli, cauliflowers, Seville beans, or early peas reach the market in quantities. The "pot" hamper is rapidly going out of use and will doubtless disappear altogether in course of time.

To the market-gardener the cultivation of spring cabbage is in the nature of a gamble; he plants in hope and often reaps in despair.

Strains. The type of spring cabbage grown is ruled by the market supplied. Small, conical-headed sorts find small favour in the West Midlands and are rarely seen outside private gardens. In the autumn of 1937, an inspection trial of 31 well-known stocks was planted at the County Experimental Station. Although dry weather in the following spring reduced its real value, only those originating from Myatt's Early Offenham satisfactorily withstood the conditions, and among them the Evesham derivatives were conspicuous. Allied strains have been planted from time to time in demonstration plots for comparison with others of market repute, but the latter have never surpassed the County selections.

Evesham strains, constantly selected and re-selected by local growers, dominate Worcestershire plantings; variations among them are slight, though easily detected by a trained observer. In comparison with other distinct stocks, they would be described as somewhat "leggy," large in size with a broad base and conical outline; the space between the basal leaves is not so wide that too much stalk is exposed when cut for market. Full hearting is rarely allowed, as the produce is more succulent and saleable while still relatively young.

THE CONTROL OF ONION FLY*

(*Delia [Hylemyia] antiqua* Meig.)

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Experiments carried out in 1936-37 attempted to compare and assess the value of several methods of onion fly control. The results showed that little control was obtained by the use of deterrents and that organic mercurials, used as seed dressings, were of little or no value for this purpose. Further, satisfactory results were not obtained either by three applications of corrosive sublimate or by three sprayings with a mineral oil emulsion. They showed, however, that by coating the seed before planting with an equal weight of calomel (mercurous chloride) a good control of heavy onion fly infestations could be obtained. Under similar conditions of attack calomel used at half rate gave unsatisfactory results.¹

Dustan, working in Ontario, Canada, has recently recorded² similar observations and results. He has shown that the calomel seed treatment not only gives a better control but, as a rule, is also much cheaper than the corrosive sublimate or mineral oil methods. Consistent results were obtained with calomel, but those obtained from the use of corrosive sublimate were variable; in one instance two applications not properly timed gave practically no control.

In experiments conducted by the writer against this pest during 1938, an attempt was made to ascertain the most economical method and rate of application of calomel necessary to procure a satisfactory control. In one experiment at the Horticultural Research Station six treatments were included:—

Treatment I. Seed treated with calomel at the rate of 1 lb. per 1 lb. of seed. Dilute flour paste used as sticker.

Treatment II. Seed treated with calomel at the rate of $\frac{1}{2}$ lb. per 1 lb. of seed. Dilute flour paste used as sticker.

Treatment III. Seed untreated. Seedlings given two applications of 4 per cent. calomel dust, first application at "needle" stage, 2nd application 10 days later.

Treatment IV. Seed moistened with dilute flour paste only before planting.

Treatment V. Seed treated with ground limestone at rate of 1 lb. per 1 lb. of seed. Dilute proprietary liquid adhesive paste used as a sticker.

Treatment VI. Control, seed and seedlings untreated.

* For a description of this pest and an account of the previous experiments, reference should be made to this JOURNAL, February, 1938.

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Treatments IV and V were included to satisfy considerations mainly of an academic nature. For example, by a comparison of the behaviour of plots under Treatment IV with those untreated, any important effect on degree of infestation produced by the paste solution alone would have been visible. Similarly, the physical effect of a powder, located near the site of attack, on infestation was largely measured by the substitution of finely ground limestone for calomel as in Treatment V. The results showed that neither of these treatments had any marked influence on the extent of infestation. The attack on both series of plots was severe and not significantly different from that on the control plots at any time during the season.

The variety Rousham Park Hero was sown on May 3 at the rate of 1 oz. per 28.3 row-yards. This corresponds to a rate of 32 lb. per acre for rows set 1 ft. apart. Each plot consisted of a double row of onions two yards long. Germination on all plots was good and even. Counts made at the "needle" stage showed the seedling rate to be highest on those plots sown with calomel-treated seed. This effect has been noticed in other experiments and is, if one can hazard an explanation, probably due to the preservation of the food reserves of the seed from the attack of soil organisms, since calomel has marked fungicidal properties.

Adults of the first and second generations of onion fly were common on these plots during the periods mid-May to end of first week of June, and last week of June to mid-July, respectively. Damage from the second generation larvae, however, was considerably greater than from the first, in spite of the much larger size of the host plants. This appeared to be mainly a result of the drought conditions prevailing during the egg-laying period of the first generation, since the survival of newly-hatched larvae seems to be favoured by moist soil conditions.

The first application of 4 per cent. calomel dust was made on June 1 when the plants were about $1\frac{1}{2}$ in. high and the majority still in the "loop" stage of development. The dust was applied with a hand duster at the rate of 1 lb. per 50 row-yards or $3\frac{1}{2}$ cwt. per acre for rows set 9 in. apart. By holding the duster over the rows and near to the seedlings a continuous light cover of dust was obtained on the soil round the latter. An examination made on the day of application revealed that onion fly eggs were present in the soil near the



FIG. 1 -- Comparison of calomel treated and untreated plots after attack by second generation of Onion Fly -- Seed treated with 1 lb. calomel per pound of seed

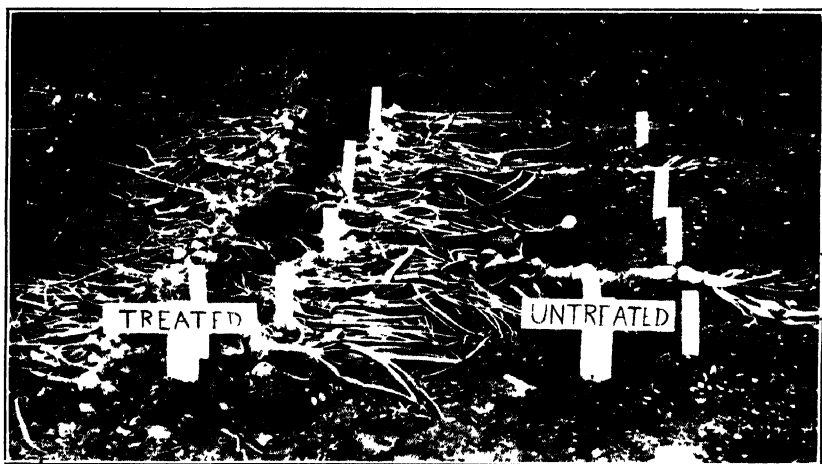


FIG. 2 -- Crop produced on the two plots shown in Fig. 1



FIG. 3 -- Effect of storage-container on viability of calomel-treated onion seed. Pot I, Untreated seed stored in cardboard box. Pot II, Untreated seed stored in glass bottle. Pot III, Treated seed stored in cardboard box. Pot IV, Treated seed stored in glass bottle. Seed treated and stored 7.9.1938. Sown 21.10.1938.



FIG. 4 — Effect of storage-container on viability of calomel-treated onion seed. Pot

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plants and that a small percentage had hatched, and very small larvae were found in plants on the calomel dust and certain other plots. As a result, these first generation larvae caused a loss of some 8 per cent. of the plants in this treatment as compared with a 2 per cent. loss on the calomel pre-sowing treatments. It is suggested that had this first application of dust been put on some four days earlier the damage on these plots would have been substantially reduced. On June 11, all plots in Treatment III received a second application of calomel dust similar in rate to the first.

Counts of attacked and unattacked plants were made on July 15, when the attack by the second generation larvae was at its height. On each plot, four sections of row, each 1½ ft. long, were examined, and Table I shows the figures obtained.

TABLE I

Treatment	I	II	III	IV	V	VI
Average number of healthy plants per foot of row ..	25.5	21.1	19.0	5.5	7.5	6.1
Percentage of plants attacked	3.0	5.2	10.1	66.5	60.4	68.5

By the end of July the larvae had mostly pupated and little further damage was caused by this generation. The severity of this second generation attack was such that every plant in one plot of Treatment IV was killed, whilst the average plant rate on the plots of Treatments IV, V and VI (control) was about one per row-foot. Fig. 1 shows one of these plots, together with one sown with calomel-treated seed (Treatment I). Fig. 2 shows the crop from these two plots.

A third generation of flies emerged in late August and early September, but the resulting attack was slight and few plants were killed.

The onions, having been previously pulled to ripen, were harvested in early October, when the figures shown in Table II were obtained.

A statistical analysis of the plot weights showed that calomel at 1 lb. per 1 lb. seed (Treatment I) had given significantly better results than calomel used at three-quarters this rate (Treatment II). Treatment III (4 per cent. dust), however, gave yields not significantly different from either Treatments

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TABLE II.—ONION CROP HARVESTED OCTOBER, 1938

Treatments	I	II	III	IV	V	VI
Total weight of undamaged onions from 6 plots ..	lb. oz. 28 9½	lb. oz. 20 15½	lb. oz. 25 6½	lb. oz. 5 6	lb. oz. 4 10	lb. oz. 3 7½
Increase in weight of undamaged crop compared with controls (percentage) ..	728.5	507.2	636.2	55.6	33.9	
No. of bulbs attacked by third generation of onion fly (percentage) ..	7.1	10.2	7.3	14.3	15.5	21.5

I and II. The difference between the yields from Treatments IV, V and VI was similarly not significant, indicating that stickers, with or without a non-toxic powder, applied to seed before sowing had little or no effect on onion fly attack.

The percentage number of the bulbs damaged by the third generation larvae is considerably lower for Treatments I and III than for those in which no calomel was used (IV, V and VI). This suggests that the calomel was still somewhat effective when the third generation eggs were laid, a period of three or four months after application. An observation made at the time of harvesting the above onion crop supports this possibility. Numbers of seed coat remains unearthed on plots of Treatments I and II were found to bear readily perceptible quantities of a white powder. Such a powder was found to be absent from the seed remains on the plots of all other treatments. Subsequent laboratory tests have shown that a deposit, approximately 1 mm. thick, of a 4 per cent. calomel dust may be exposed on the surface of moist soil for three months in a heated glasshouse without losing its toxicity to the eggs and larvae of certain dipterous flies.

In addition to a low yield and a high percentage of damage, the onions on plots of Treatments IV, V and VI were, in general, thick-necked and of very poor quality, whereas all three calomel Treatments gave good quality crops of small onions suitable for pickling.

Trials. In 1938, trials were carried out in four school gardens in Cambridgeshire. A replicate was also carried out at the Horticultural Research Station, Cambridge. Half the experimental seed was treated before sowing with an equal

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weight of calomel and the other half was sown untreated. Treated and untreated rows were sown alternately. The total number of seedlings were counted at the "needle" stage, and later the rows were thinned, leaving the plants about 2 in. apart. During the summer, attacked plants were found at all centres but the damage, except at Cambridge, was nowhere severe. At harvesting, the crops from the untreated and treated rows were weighed separately.

TABLE III.—TRIALS IN CAMBRIDGESHIRE. NUMBER OF SEEDLINGS AND CROP WEIGHTS ON EQUAL LENGTHS OF TREATED AND UNTREATED ROWS

Centre	Total number of Seedlings in :		Total Crop Weight Harvested from :	
	Untreated Rows	Treated Rows	Untreated Rows	Treated Rows
			lb.	lb.
Cottenham	430	667	4.5	5.5
Fowlmere ..	1,165	1,376	27.0	33.0
Gamlingay ..	1,017	1,312	8.75	11.75
Sawston (a) ..	1,796	1,596	13.0	13.5
Sawston (b) ..	162	213	2.0	4.0
Cambridge ..	1,419	1,605	2.9	5.8
TOTAL ..	5,998	6,769	58.15	73.55

The seed treatment is seen to have increased the seedling rate at all except one centre, and to have doubled the crop weight at two centres and increased it in the remainder.

Control of Onion Fly on Leeks. The larvae of the onion fly may also cause severe damage to leeks. The attack usually occurs in early summer before the plants have been set out or thinned. As with onions, the maggots eat into the underground portions, killing the plants.

Although no field trials with leeks have been carried out, pot experiments have shown that by treating the seed prior to sowing with an equal weight of calomel a very satisfactory maggot control can be obtained. It is probable that a 4 per cent. calomel dust, applied as for onions, would give similar results. An inducement to practise pest control on leeks is the high price of the seed.

Effect of Calomel Seed Treatment on Germination. In three field trials in which calomel-treated seed was compared with untreated seed, the numbers of seedlings on the plots sown with treated seed were in all instances greater than on

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those sown with untreated seed, but the difference failed to reach statistical significance. Indoor tests for germination in soil have been carried out by the National Institute of Agricultural Botany and by the writer, and have confirmed the findings of these trials. Further, examination showed that application of calomel to the seed before sowing produced no apparent adverse effect upon vigour, height, root development or general appearance of the resulting plantlets. Germination and subsequent plant development of leeks are similarly not impaired by calomel treatment of the seed. In the above germination trials and tests the treated seed was sown immediately after treatment or kept for short periods only in paper packets before sowing.

When a calomel-treated sample of onion or leek seed is stored, the subsequent viability of that sample is dependent on the type of container used. Treated seed stored in closed wooden, paper or cardboard containers or on open trays maintains a viability which compares favourably with untreated seed similarly stored. Germination tests carried out on treated and untreated seed stored five months in closed cardboard containers showed the treated seed to possess the slightly higher viability.

If, however, the treated seed be stored in closed glass or metal containers damage results. This becomes obvious in seed stored about 2 weeks, as seedlings produced from such seed appear stunted and malformed, the root often failing to respond normally to light and appearing above ground. The viability of the sample rapidly falls and the percentage

TABLE IV.—EFFECT OF STORAGE-CONTAINER ON THE VIABILITY OF CALOMEL-TREATED ONION SEED. (VARIETY: WHITE LISBON.)

Test Number	Date of Sowing	A Treated and Stored in Closed Glass Bottle	B Untreated and Stored in Closed Glass Bottle	D Treated and Stored in Cardboard Container	E Treated and Stored in "Cocoa" Tin
1	12.12.38	63%	59%	63%	62%
2	2.12.38	460	493	545	385
3	18.12.38	418	482	469	217
4	2. 1.39	327	488	509	87
5	14. 1.39	46%	57%	65%	2%
6	17. 1.39	301	427	516	41
7	1. 2.39	182	416	541	0

The figures for Tests 1 and 5 are the percentage germination of the seeds and those for the remainder of the Tests are the numbers of seedlings, obtained from 4 gramm. of seed.

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of abnormal seedlings increases until, after some 10-16 weeks, varying with the type of container, the whole sample is killed. (See Figs. 3 and 4.)

The four samples A, B, D and E were obtained by the subdivision of a single bulk sample. Three of these, A, D and E, were treated with an equal weight of pure calomel. Treatment and storage were both carried out on November 15, 1938. The untreated sample B was stored in a corked glass bottle. All germination tests were carried out in soil. Tests 1 and 5 were made by the National Institute of Agricultural Botany and the remainder by the writer. The seed used in Test 1 was taken from the samples on the day of treating and kept in paper packets until sown. The test showed that treated seed so stored gives an increased rate of germination compared with untreated seed, as does seed sown directly after treatment.

In the remaining tests the seed was removed from the storage containers on the day of sowing. In those carried out by the writer 4 grm. of untreated seed or 8 grm. of treated (4 grm. of seed and 4 grm. of calomel) were used per sample per test. The figures in the table show the total number of seedlings produced by these weights of seed. During storage the treated sample D is seen to have changed little in viability and to have maintained throughout a germination superior to that of the untreated sample B. In contrast, the viability of samples A and E fell off rapidly with storage.

Other experiments have shown also that treated seed can be stored unharmed in closed wooden containers or in open trays. Calomel-treated leek seed is similarly affected by the above range of storage containers.

Selection of Method of Control. Since the seed treatment and the post-germination dust treatment both effectively control onion maggot, the choice of the method to be employed must depend largely on relative costs. These will vary with the seed rate used and the intensity of the expected attack.

When dealing with severe infestations of onion fly, it is necessary either to treat the seed with an equal weight of calomel or to give two applications of 4 per cent. calomel dust, each at the rate of about $3\frac{1}{2}$ cwt. per acre, to obtain a satisfactory control. The cost of seed treatment per acre will therefore vary directly with the seed rate used.

The calomel dust, to be fully effective, should form a continuous cover on the soil both along the rows and to a distance

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of $1\frac{1}{2}$ in. on either side. For any given row spacing, the quantity of dust required per acre will vary little with the density of plants in the rows. At current prices calomel costs about 8s. per lb., and 4 per cent. calomel dust about 35s. per cwt. Under conditions of severe infestation, where maximum dressings are required, for seed rates of 30 lb. per acre and less the seed treatment method is the cheaper. For seed rates in excess of this figure the dust method would be the more economical.

With moderate to slight infestations in green (bunching) or pickling onions, where high seed rates are normally used, recent experiments² have indicated that a satisfactory commercial control will be obtained if the seed is treated with one-quarter of its weight of calomel before sowing. Any excess of sticker should be taken up by the addition of an inert powder, such as gypsum or fullers' earth. With a similar intensity of attack, but with a seed rate of 10 lb. or less, calomel should not be used at a rate lower than $\frac{3}{4}$ lb. per lb. of seed. Under these conditions also, a single application of 4 per cent. calomel dust, put on in mid-May, should give much protection. The dust should be disturbed as little as possible after application; such operations as weeding and thinning should be carried out before dusting.

Summary. Calomel applied to onion seed before sowing, at the rate of 1 lb. per lb. of seed, effectively controls heavy onion fly infestations. Similar results can be obtained by two applications of 4 per cent. calomel dust applied along the rows after germination.

Onion fly in leeks can also be controlled by treating the seed with calomel before sowing.

Calomel-treated onion seed, sown directly after treatment, gives a better germination than untreated seed. This superiority is maintained during storage if the container used is of wood, cardboard or paper. If stored in closed glass or metal containers, however, the viability of treated seed is reduced and the sample is soon killed.

ACKNOWLEDGMENTS. The writer wishes to thank Mr. D. Boyes, M.A., and Mr. F. R. Petherbridge, M.A., for valuable suggestions and criticisms. Thanks are also due to Mr. C. C. Brett for carrying out germination tests and to all who have afforded facilities for carrying out trials.

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FEEDING STANDARDS FOR FARM ANIMALS: II. THE ENERGY REQUIREMENTS

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Last month, the dry matter requirements of farm stock were discussed, and it was made clear that standards for dry matter are in reality a measure of the capacity or appetite of an animal rather than of its actual nutritional needs. In order to assess the latter it is not only necessary to sub-divide the ration according to its content of individual nutrients (expressed in terms of energy, protein, minerals and vitamins), but to determine separately the requirements for each individual function, i.e., for maintenance, growth, fattening and milk production. The present article is devoted to a consideration of the energy requirements for these four functions.

The Basis for Determining the Maintenance Requirement. The maintenance ration is designed to supply the energy used in the normal upkeep of the body, i.e., in the maintenance of body temperature, the continuance of such vital functions as circulation and respiration, and the muscular movement incidental to normal life. In tables of feeding standards (such as those in the Ministry's Bulletin*) the maintenance requirements are invariably expressed per unit of live weight, a method which is of obvious convenience to the practical breeder. Closer examination of such tables will show, however, that the requirements are not in fact proportional to the live weight, but that the requirements of small animals are relatively greater than those of larger ones. Thus, while the weekly maintenance requirement of a 70 lb. sheep is given as 7 lb. of starch equivalent, that of a 140 lb. sheep is not 14 lb. but only 11 lb. of starch equivalent. The reason for this is that in formulating the standards it has been assumed, on the strength of certain early experimental evidence, that the basal metabolism (which is the minimum amount of energy required by an animal for the continuance of the vital functions of the body, and on which its maintenance requirement is therefore based) is proportional to the surface area

* *Rations for Live Stock.* T. B. Wood and H. E. Woodman, Bulletin No. 48 of the Ministry of Agriculture. Tenth Edition now in preparation.

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of an animal and not to its weight. Since it is difficult to measure the surface area directly, it has usually been calculated on the assumption that body surface is proportional to the two-thirds power of the body weight.*

During recent years it has become increasingly apparent that the use of the surface area as a basis for calculating the basal metabolism of an animal is subject to serious theoretical as well as practical difficulties. Part of these difficulties are associated with the actual measurement of the surface area. The skin is elastic and flexible, and attempts to gauge the body surface by measuring the area of the hide of slaughtered animals are therefore subject to unknown errors. Again, in calculating the surface area mathematically, the exact geometrical configuration of the body (to which the surface area must be related) cannot be accurately determined. Other difficulties are associated with the position and covering of the body surfaces. For example, the lower (ventral) surface of the animal may radiate a different amount of heat from that of the upper (dorsal) surface, while some parts of the body surface are so close to one another that heat losses will be relatively small. Again, some animals, such as sheep and cattle, have an insulating layer of wool or hair of variable thickness which will minimize heat losses, while others, such as pigs, have a relatively bare body surface. It is not therefore surprising that modern workers have not only found that the relation of the surface area of the body to live weight may vary within relatively wide limits (according to recent work the value may lie anywhere between the two-thirds and three-fourths power), but that the constancy of the ratio of body surface to basal metabolism cannot be upheld even for adult stock.

The above difficulties have led to a re-investigation of the relationship of basal metabolism to body size. The most extensive studies of the subject so far published have been made by two American workers, Brody, of the Missouri Agricultural Experiment Station, and Kleiber, of the California Station. Kleiber examined statistically the basal metabolism of animals varying in size from rats to steers, while Brody's data covered even greater extremes of body size, i.e., from mice to elephants. Both authors arrived at substantially the

* The formula commonly employed is $S = .0531 \times W^{.67}$, where the surface area (S) is measured in square metres and the body weight (W) in pounds.

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same conclusions, namely, that the most satisfactory basis for relating basal metabolism to body size is to use a direct function of the body weight rather than to attempt to introduce any conception of surface area, and that the best relation is obtained by employing the three-fourths power of the body weight ($W^{\frac{3}{4}}$, or more accurately $W^{0.73}$) rather than the two-thirds power ($W^{\frac{2}{3}}$).

The practical implications of these conclusions are two-fold. In the first place, it appears that, if the above conclusions are valid, *it will be necessary to modify the existing rationing tables relating live weight to maintenance requirement so as to allow for the difference between the two-thirds power, which is the present basis of calculation, and the proposed three-fourths power.* The extent of the necessary amendments (which are relatively small) may be illustrated by stating that, if the standard requirement for a 100 lb. sheep is taken as 9 lb. starch equivalent per week, the existing standard of 14 lb. for a 200 lb. animal will require to be increased to roughly 15 lb., while for cattle the requirement of a 15 cwt. animal will need to be raised by about $\frac{1}{4}$ lb. starch equivalent per day.

In the second place, if (as Brody and Kleiber's results appear to show) the above relationship of basal metabolism to the three-fourths power of the body weight holds for all animals, *this relationship might possibly be used in future as a basis for a universal system of rationing which could be applied to all classes of stock.* Such a proposal was indeed put forward at a recent Conference on Energy Metabolism held in Pennsylvania. Briefly the proposals may be summarized as follows:—The basal metabolism of all animals is calculated from a single equation. The equation suggested by Brody* would give the basal metabolism of a 1,000 lb. ox as 6,110 Cal. and of a 100 lb. sheep as 1,140 Cal.—figures which are remarkably close to those which form the basis of our own feeding standards. To this value would be added a percentage varying with the activity of the stock in question.† Active species, such as racehorses, would require

* The actual equation suggested is $Q = 39.5 W^{0.73}$, where the basal metabolism (Q) is measured in calories of net energy and the live weight (W) in pounds.

† Brody, in formulating this system of rationing, actually recommended the use of metabolizable rather than of net energy as a basis for animal feeding standards. This does not, of course, affect the general principle involved.

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more than draught horses, dairy cows more than beef cows, pigs more than sheep, cows at pasture more than cows in sheds. Similar adjustments would presumably have to be made for differences in sex, age, breed, and other factors which are known to affect the energy requirement. The final figure would give the overall maintenance requirement of the animal.

Such a system is superficially attractive on account of its relative simplicity and of the apparent ease with which it could be applied to all classes of live stock. On the other hand the proposal is not free from criticism even on theoretical grounds. For instance, while basal metabolism itself may be proportional to the three-fourths power of the body weight, there is no evidence that the activity factors would show a similar relationship. In fact, the investigations of the Cambridge School on the energy requirements of pigs indicate that, as far as muscular activity is concerned, the requirement is more or less constant at all ages and is entirely independent of live weight. This is attributed to the fact that, while young pigs are more active, older animals have to expend increased muscular energy in moving their heavier bodies. Again, insufficient information is as yet available regarding the effect of alterations in environmental conditions and plane of nutrition on energy requirements. It is therefore clear (as Brody himself states), that much research would be required before such a simplified rationing system could in any event be formulated. Moreover, it is questionable whether such a system would be as simple in practice as it appears in theory, and whether (what is more important) it would have any real advantage over the system of rationing at present in vogue in this country. The latter has been evolved by a skilful combination of scientific experiments and practical feeding trials; it is sufficiently elastic to allow for any substantial changes in environment or muscular activity (e.g., for housed *versus* grazing stock with cattle, and for light, medium and heavy work with horses), and it has been found to be both convenient and effective in practice. It does not seem likely, therefore, that the general principles underlying the rationing system set out in *Rations for Live Stock* will need any drastic revision meantime.

Actual Maintenance Requirements. The retention of the present system of rationing as laid down in *Rations for Live*

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Stock does not, however, imply that the figures there given do not need occasional revision. There are, indeed, reasons for believing that the standard energy requirements of both cattle, sheep and pigs already call for amendment.

As regards cattle, the present standard is 6 lb. starch equivalent per 1,000 lb. live weight. Values calculated from the work of a number of investigators show, however, that the actual requirements may vary between 4.7 and 7.0 lb. Halnan, as a result of an exhaustive study of the literature, concludes that as an average value 6 lb. is definitely too high, and suggests that the standard could safely be reduced to 5 lb. This appears to be a somewhat drastic reduction, and *meantime it would perhaps be safer to take the mean value of all available figures, namely 5½ lb. starch equivalent per 1,000 lb. live weight.* In this connexion it may be noted that the carbohydrates of a ration are capable of exerting a protein-sparing action, and that in order to obtain full advantage from the food protein, it is therefore desirable to exceed rather than to fall short of the actual energy requirement.

As regards sheep, Scott Watson and his colleagues have for some years urged that the standards laid down in *Rations for Live Stock* require amendment, on the ground that the figures for dry matter are beyond the capacity of most sheep, and that the estimated requirements of sheep for energy are also too high. From a re-analysis of data from a number of older experiments, these authors consider that the existing standard of 1½ lb. starch equivalent per 100 lb. live weight per day should be reduced to less than 1 lb., while their own feeding trials indicate that the dry matter content of the ration should also be substantially reduced. Recently, Woodman of Cambridge has made a careful re-investigation of both these points, and his conclusions (which will be incorporated in the next edition of *Rations for Live Stock*) show that, *while Scott Watson's figure of 2¾ lb. as the daily dry matter capacity is a more accurate estimate than the late Professor T. B. Wood's value of 3½ lb., the latter's suggested standard of 1½ lb. starch equivalent for the daily energy requirement per 100 lb. is correct.* It may be noted that the latter figure corresponds closely with the experimental value recently obtained by Benedict and Ritzman in the United States, while it also coincides with the figure calculated by Brody's formula provided that an addition of 10-15 per cent. is added to the basal metabolism to allow for normal muscular

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movement. One interesting conclusion which may be drawn from Woodman's results is that, for optimum success in fattening, *it is apparently necessary to use a ration somewhat richer in energy than had previously been advocated*, since with the new standards the same quantity of energy must be included in a smaller amount of dry matter.

As regards pigs, different investigators give widely varying estimates of the energy requirements for maintenance. Existing British standards are derived from Wood's 1926 tables, which are, incidentally, based on surface area calculations. They admittedly include an exceptionally large allowance for muscular activity, amounting to about 1,000 Cal. (or one pound of meal) per day, but even when this is deducted the resulting basal figures are much higher than those given by American workers, such as Armsby, or those calculated by Brody's formula. For an animal of 100 lb. live weight the respective figures of these three authorities are, for example, 1,900, 1,250, and 1,140 Cal. This lack of agreement is partly due to the fact that young pigs have an exceptionally high rate of basal metabolism in comparison with other species, and is partly associated with the marked differences in growth rate and age of maturity of the various breeds. *The most recent figures indicate that the standards laid down in Rations for Live Stock might justifiably be reduced*, but the exact extent of such reduction must await the results of further research.

Production Requirements. The production requirements of live stock, whether for growth, fattening or milk, have been arrived at as a result of extensive feeding trials, supplemented by more accurately controlled balance experiments. In such feeding trials the object of the investigators has naturally been to arrive at reliable *average* values which would be generally applicable to each class of stock. In other words, a definite attempt has been made to eliminate any effect of individual variability which might be due to differences in the efficiency of particular animals. This was obviously necessary in formulating standards for the general guidance of breeders, but it has inevitably tended to divert attention from the important question of the *individual response* of different animals to the same ration.

While recent results indicate that existing energy standards for growth, fattening, and milk production do not apparently

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require any substantial modification, there has been a marked tendency among workers in animal nutrition to lay increased emphasis on factors affecting the efficiency of food utilization and particularly on individual variations in efficiency. As early as 1914 the late Professor T. B. Wood directed attention to the wide differences which occur between individual animals in their capacity to convert food into fat. He found, for example, with fattening cattle, that where the average live weight increase per head was 1.8 lb. per day, one in every four animals increased by more than 2.1 lb., and one in four by less than 1.6 lb., a difference in efficiency of about 30 per cent. In many instances very much wider differences were noted. Incidentally, Wood and A. V. Hill attempted with some success to apply measurements of skin temperature to differentiate between good, moderate and bad "doers," an interesting line of investigation which does not appear to have been followed up. Recent investigations have confirmed Wood's observations and have extended them to other classes of stock and to functions other than fattening. Thus, an investigation at the Minnesota Agricultural Experiment Station has shown that the efficiency of live weight increase of individual steers may vary so as to alter the cost per 100 lb. live weight gain by as much as 30-40 per cent. Similar results have been obtained with pigs, while with dairy cattle one group of American workers found that the range of efficiency in converting food energy to milk energy varied from 18-24 per cent, while another group observed even wider limits, i.e., 18-40 per cent. There appears to be no doubt that these differences in efficiency are inherited. Studies with pigs have shown that a group of outbred animals gave higher coefficients of digestibility than a comparable group of inbred animals, while similar significant differences were also found between the progeny of three different boars. The Minnesota workers have, too, shown that it is possible to select for high efficiency: by experimental breeding they were able to develop two strains of rats, one of which showed not only 40 per cent. greater efficiency, but markedly less variability than the other.

Two practical conclusions emerge from the above findings. In the first place, the results show clearly that *the level of efficiency of food utilization of his stock will depend to a considerable extent on the observation and subsequent breeding methods adopted by the stock owner.* The elimination of

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poor "doers" and the selection of the most efficient strains for breeding should tend to raise the general level of efficiency of food utilization. In the second place it is obvious that, while existing feeding standards are invaluable as a general guide to stock owners, *it is necessary in applying them to allow for individual differences in the efficiency of stock.* As Woodman has recently written, "Tables of feeding standards and digestible composition are at best intended only to afford guidance in the computing of rations; adjustments, based on the breeder's observation of the progress of his animals, is usually necessary and, in the very nature of things, almost inevitable when the computed ration is tested out."

A SUCCESSFUL CORN AND POULTRY ROTATION

AN ACCOUNT, BY MR. A. BRIDGES, OF MR. W. S. ABBOTT'S
FARM AT SACREWELL, THORNHAUGH, PETERBOROUGH

For many years prior to the Great War English farming had been moving to a higher proportion of grass land. Ever since the War the process has continued, and there have been unmistakable signs that the systems of crop production, on which our livestock farming was built up and maintained, have been steadily yet surely crumbling. Live stock are depending more and more on grass and imported foodstuffs than on the products of our own arable land.

In 1921, out of a total area of crops and grass of 26,144,071 acres, there were 14,525,835 acres of permanent grass, 2,699,894 acres of temporary grass, and 1,419,644 acres of fodder roots; the proportions of grass (permanent and temporary) and roots to the total were 65.9 and 5.4 per cent. respectively. In 1937, the total area of crops and grass was 24,780,321 acres, the area of permanent grass was 15,756,521 acres, of rotation grasses 2,294,532 acres, and of fodder roots 493,997 acres; the proportions of grass and roots to the total have become 72.9 and 2.0 per cent. respectively.

The folding of sheep on roots and the feeding of bullocks in yards and the carting of dung, on which the four-course rotation was built, and on which the fertility and cleanliness of the soil depended, have been given up, or severely curtailed, because the system no longer pays.

The four-course rotation and its variants were designed primarily for sheep and cattle, and there was no place in them for pigs and poultry. With the enormous growth in both of these branches of live stock during the post-War period, it has become imperative, with the unprofitability of the traditional rotations, to endeavour to replace them with others which would make it possible to maintain the productivity and cleanliness of the soil. This article is concerned with a successful corn and poultry rotation on the arable farm of Sacrewell, at Thornhaugh, near Peterborough. The farm is 593 acres, of which two-thirds are arable. The stock consists

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of a tuberculin-tested herd of 45 Shorthorn dairy cows and young stock and 200 Half-bred x Suffolk ewes. Prior to 1935 there were also 50 sows and their progeny and approximately 2,000 head of poultry, but two or three years ago the pigs were moved to another farm and their place has now been taken by additional poultry, making the flock up to nearly 4,000 head. The pigs had been profitable for several years, but the new farm was considered to be more suitable for them, and the poultry had by this time proved to be an equally good, and even a better paying branch. These adjustments were made also to simplify the working of the farm. Mr. Abbott's view is that farm organization is often too complicated and involved for efficient management.

The departmental system of farming practised at Sacrewell has been described in detail elsewhere,* and all that is necessary to state here is that the general principle is to have a separate part of the arable land of the farm for each of the main classes of live stock, with its own rotation of cropping. Direct manuring on the land is practised wherever possible. Each class of live stock has its own specialized labour staff; there is also a specialized staff for working the land, with the addition of a number of men who are moved where required by the pressure of work.

On the arable land no fodder roots are grown. The farmyard manure is chiefly used for sugar-beet and potatoes, of which about 45 and 30 acres respectively are usually grown each year. The amount of hay made every year is not large. Every effort is made to maintain the stock by grazing on permanent and temporary grass, and the feature of the grazing is the production of winter and early spring grass, in order to reduce the demand for hay and roots.

The system of corn and poultry farming may be described under two heads: (a) the management of the land, and (b) the management of the stock.

Up to 1938, rather over 100 acres of arable land have been reserved for the poultry. The rotation followed is a two-years ley, followed by two years corn. The seeds mixture used is perennial rye grass and Dutch white clover.

The new seeds are first grazed by sheep or mown for hay, and the poultry are put on them at the end of June for a year.

* *Flexibility of Farming*. A. Bridges assisted by E. L. Jones. Oxford University Press.

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During this period they occupy about 3 acres only at any one time, and the remainder is kept short by mowing, or grazing by sheep, whichever is more opportune. In the second year, from March 1 onwards, ewes and lambs graze behind the poultry; the seeds are broken up at the end of June and the land bastard-fallowed in preparation for corn. Up to the present, two years of wheat (Little Joss) have been taken after the seeds. Occasionally, a crop of beet or potatoes takes the place of the first wheat crop if the fallow has not been very successful.

The objects of the plan are to manure the land by means of the poultry, to provide the humus by means of the seeds, and to avoid any further manuring, except perhaps a nitrogenous top-dressing for the second corn crop. These objects have been achieved. Dung carting has been eliminated, little artificial manure has been used, and a lot of wheat straw has been sold. Both the first and second year's corn crops have been good, and although no separate records are kept of the yields of wheat in the poultry rotation, they have been better than the average for the whole of the farm. Besides providing space and grazing for the poultry, the seeds keep about 100 ewes and their lambs during the summer months. The earliest grazing on the farm is on the poultry land as the poultry manure provides an early "bite," and this is used for the production of early fat lamb. This is an added advantage on a dry farm from which it is desirable to sell as much stock as possible before the summer drought. In addition, 5-10 cwt. of hay per acre is produced from the total poultry seeds area, the amount varying considerably from season to season.

As to the management of the stock, day-old chicks are bought in 4 batches, the first early in January. Up to 1937, the practice was to buy three batches of mixed Rhode Island Reds and the fourth batch of sex-linked pullets (Rhode Island x Light Sussex) so as to avoid too large a number of late cockerels. The cockerels, then regarded as a necessary evil, were separated from the pullets as soon as possible and fattened in arks, which, with a run attached make a suitable type of house for the purpose. In 1938, however, sexed pullets were bought, thus eliminating the cockerels.

The stock is kept till the birds are roughly two years old, culling up to 27 per cent. in the pullet year, and selling the remainder as they stop laying from December to March.

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This frees the laying houses for the rearing of the young stock in the new year. It also maintains a supply of good-sized eggs until the pullets come to full production.

Approximately 2,000 head (1,000-1,300 pullets and 800-1,000 hens) provide a satisfactory stocking for 100 acres of land on the rotation described. The poultry utilize approximately 25 acres of seeds divided as follows: the pullets run over 13 acres in the 12 months from June to June, the hens, 6 acres from June to December, and the remaining 6 acres are occupied by the young stock from the time they are put out in spring till June. About 120 tons of foods are fed to the poultry during the year. In this way the residues of some 4-5 tons of foods are applied per acre; or 1-1½ tons over the whole area reserved for the system, in addition to which there are the residues from the grazing of sheep.

This system gives a fairly even distribution of labour, because as the hens are sold, the chicks take their place, but a little extra help is required for chick-rearing, at a time when other work on the farm is normally slack. Two men are employed to rather over 2,000 birds. In addition to the routine work, which includes moving on the pens, they do the rearing, a certain amount of plucking, and some egg-grading and packing, besides carpentry at times. Possibly they could manage more birds, but it is more important to have careful and efficient supervision than to cut labour too fine.

The method of folding is as follows: the slatted-floor houses are placed at equal distances apart, in a row across the seeds. They are enclosed by a wire pen of about 150 × 100 yd. for a thousand birds, thus giving the benefits of practically free range. This pen is formed of 5-ft. wire-netting hung on larch stakes. Within this pen the houses are moved on, weekly, such a distance that they will cover their allotted acreage of seeds in the year. As soon as the houses have moved over half the ground enclosed by the pen, the wire at the back is brought up behind them and a fresh area is enclosed in front, so that half only of the area of the pen is changed at each move, in this way giving a more gradual change on to fresh ground. This pen is found to be well worth while, as it more than saves its cost by preventing the birds from damaging crops and hedges, and from laying away, and by preventing losses from foxes. It keeps the birds from running back on the fouled land (the manure from the dropping boards is also

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spread on the land behind the pen) and gives the seeds a chance to recover and grow.

The hens and pullets have separate pens. Slatted-floor houses of a well-known make, holding 60-80 birds were used at first. Latterly, simpler houses, specially designed, holding about 90 birds, have been used. They have the merits of durability and cheapness. Drymash hoppers are placed outside the houses, and water is held in 40-gal. barrels, from which the drinking-troughs are filled. Old colony houses are used as food-stores, and two old semi-intensive laying houses as brooder houses. The investment in stock and equipment is about £7 per acre, stock accounting for £3 and equipment for £4, the latter being valued as new. It is now convenient to give the technical and financial results of this system of farming for the past 3 years. From a technical standpoint, the system of folding has been good. The output of eggs is high. The yield from the pullets has been as follows:—

TABLE I.—EGG YIELD PER PULLET*

Michaelmas to Michaelmas

			1935-6	1936-7	1937-8
October 11-31	..	..	9.8	8.2	7.2
November	..	..	13.0	11.3	12.2
December	..	..	13.6	12.5	15.3
January	..	..	12.1	12.7	16.1
February	..	..	11.5	11.3	16.0
March	..	..	17.7	19.0	20.2
April	..	..	20.0	20.6	19.4
May	..	..	20.9	19.0	17.9
June	..	..	16.9	15.1	16.3
July	..	..	15.7	14.5	14.6
August	..	..	15.0	14.1	13.0
September	..	..	13.1	13.0	12.9
October 1-10	..	..	3.7	3.9	3.8
TOTAL	..	..	183.0	175.2	184.9

* Calculated on the average number of birds during the month

These yields are exceptionally good for a large flock maintained out-of-doors. During the period from October to time of disposal in December onwards, a further 30-40 eggs are laid, so that the production from each bird is approximately 220 in 15 months.

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The birds have kept remarkably healthy, and mortality figures compare favourably with other published data :—

TABLE II.—POULTRY MORTALITY, 1935-38

	1935		1936		1937		1938	
	No.	%	No.	%	No.	%	No.	%
CHICKS :—								
Purchased	2,440	100.0	2,392	100.0	2,496	100.0	2,433	100.0
Deaths	324	13.3	142	5.9	245*	9.8	245†	10.1
Missing	—	—	—	—	2	0.1	42	1.7
Cockerels, etc., sold	892	36.6	865	36.1	861	34.5	152	6.2
Pullets (Oct. 11) ..	1,224	50.1	1,385	58.0	1,388	55.6	1,994	82.0
	1935-6		1936-7		1937-8			
PULLETS :—								
Total beginning of year (Oct. 11) ..	1,224	100.0	1,385	100.0	1,388	100.0	—	—
Deaths	49	4.0	71	5.2	86	6.2	—	—
Missing	56	4.6	73	5.2	15	1.0	—	—
Sold	132	10.8	238	17.2	370	26.7	—	—
Total end of year ..	987	80.6	1,003	72.4	917	66.1	—	—
	1936-7		1937-8		1938-9			
HENS :—								
Total	987	100.0	1,003	100.0	917	100.0	—	—
Deaths†	11	1.2	9	0.9	20	2.2	—	—
Missing	8	0.8	—	—	9	1.0	—	—
Sold	968	98.0	994	99.1	888	96.8	—	—

* To June 11, deaths were 192 (7.7 per cent.) and from June 11 to October 11, 53 (2.1 per cent.) of original stock.

† To June 11, deaths were 147 (6.0 per cent.) and from June 11 to October 11, 98 (4.1 per cent.) of original stock.

‡ The hens from the 1934 hatch had a death-rate of 2.7 per cent. and 3.8 per cent. were missing.

Deaths among chicks have averaged 10.0 per cent., among pullets 5.0 per cent., and among the hens (for 3 months) 1.4 per cent. As the first essential of good poultry husbandry is the maintenance of stock it is important to secure healthy chickens, and Mr. Abbott has been fortunate in his source of supply. The method of management provides an outdoor life with practically free range and fresh ground, all of which are important for healthy stock.

The birds supplement their food by grazing the seeds, and although they are out in all weather, the food consumption is not high. Over the three years to 1937-38, the average, including the food used for rearing, has been 195 oz., and the cost 8.1d. per doz. eggs produced.

For a corn and stock rotation, the output of this system of

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farming is exceptionally high. Taking the total acreage under the rotation, the output from poultry is £17 10s. per acre, and from wheat and straw about £4 10s. per acre, making a total of £22 without giving any credit for hay or sheep-keep. In arriving at the above figures the poultry have not been charged with the cost of the seeds; on the other hand, they have not been credited with any manurial residues. These latter are the by-product of a profitable enterprise instead of the main purpose of an unprofitable one. It is generally accepted that the sheep and bullocks of the traditional Norfolk rotation are not profitable at the present time.

The argument is constantly advanced that, to farm light land well and to keep it clean and in good heart, it is necessary to grow roots and keep the sheep-fold going. This system of corn and poultry, however, has proved to be equally effective in this sense. It is no exaggeration to state that the land in the rotation is as clean as other parts of the farm where beet and potatoes are grown. Mechanical means of cultivation have materially assisted to keep down weeds; it is also in very good heart from the manure from the heavy stocking of poultry and from the ploughing in of humus from the seeds and the straw stubbles.

Every system of crop and stock husbandry has its risks and complications, but it is difficult to imagine one which carries fewer and is simpler to operate than the system described here. A bastard fallow keeps the land clean, and wheat is planted at a favourable time for the germination of the seed and the establishment of the plant. The stock keep free from disease as they are continually moved to fresh ground, and the plough follows to give the land a rest from poultry. The rearing of the chickens and the care of the laying stock have not created any problems which cannot be solved by sound management, and the equipment has been simplified so that one type of housing suffices for laying birds and chicks after they are a few weeks old.

Like most successful enterprises, the system is simple. It is based on products for which there is a large demand, and marketing presents no difficulties as most of the eggs are sold through a packing station. Many will claim that the Norfolk system is simple, but it is so only because of its familiarity; it is a matter of some difficulty to balance the crops and stock in a dry and uncertain climate. Mr. Abbott has practised his system for 8 years and it is interesting to note that it was

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developed as an arable system and put into operation about the same time that Mr. Hosier developed his scheme of running poultry on grass land with dairy cattle.

Three years ago, Mr. Abbott cautiously expressed the opinion that the system was promising; his subsequent experience and the successful financial results fully justify the system as one eminently suitable for farming light arable land, and one capable of application over a large part of our arable farming area.

Finally, it might be objected that in these times of political uncertainty a system depending largely on foodstuffs suitable for human consumption, and others which are imported, is undesirable; on the contrary, it maintains the land in fertile condition and retains the labour and equipment necessary for its working. In an emergency, the stock could be reduced gradually, but the land would maintain its fertility for some time. The alternatives are often a half-farmed arable system which would produce very little, or poor grass land which might produce nothing till the crisis was past.

OVERHEAD IRRIGATION*

E. SKILLMAN,

Ministry of Agriculture and Fisheries

The unreliable nature of summer rainfall in this country has in recent years directed the attention of intensive cultivators to the three main systems of irrigation—surface, sub-surface and overhead spray—and the last of these has been found to be the most suitable for British conditions. Any irrigation system is attended by the disadvantages of high cost, of possible change in soil texture, and of rapid decomposition of organic manures; but against these may be set the advantages of a certain independence in the matter of weather, an ability to plan crop production and labour distribution in confidence, and an improvement in the quality of produce.

In the overhead irrigation system the water is sprayed into the air under pressure and reaches the plants and the soil as a fine mist; consequently, the apparatus should be so designed that the spray resembles natural rain as closely as possible, particularly as regards temperature, particle size and aeration. The usual lay-out consists of an arrangement of main pipes leading from a fixed or portable pump, or from the town mains, connected to series of spray (nozzle) lines. With a fixed pump, the mains may be laid below the soil surface.

Mains. The size of the mains is dictated by the area to be irrigated; mains of 3 in. internal diameter are adequate for the spraying of 1-2 acres at once, but above this area and up to 4 acres mains of 4 in. diameter, carrying 12,000 gal. an hour, would be necessary. The spray lines run out on both sides of the mains from standpipes and valves set at intervals of from 40 to 50 ft., according to the water pressure and the nozzle aperture. The number of mains required depends on the length of the spray lines, a main being required every twice the length.

* Readers who would be interested in a fuller account of spray irrigation than it has been practicable to give in a short summary may like to note that a Ministry's Bulletin on the subject is in preparation. This has been written by Mr. Skillman, and deals also with water supplies and pumping systems. It is hoped to publish this later in the season.

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Spray Lines. These vary from $\frac{3}{4}$ to 2 in. internal diameter, the usual size being 1 in., and made up of quick-coupling 16-ft. sections. They are attached to the mains either by a screw attachment or a flexible hose, and are supported on movable stakes or stands, one stand being allowed to every 16-ft. section. The stands are adjustable to keep the lines level on uneven ground.

Laid loosely on the stands, the spray line, which is provided with a turning union, can be rocked from side to side either by means of an automatic oscillator or by a handle, and the area on both sides of the line for a distance of 20-25 ft. can be covered by the spray with proper turning of the line. The length of the line may be from 50 to over 600 ft., but the shorter the spray line the greater the number of mains that will be necessary.

It is not usual for the whole area to be provided with spray lines permanently fixed in position; after one portion is watered the lines are uncoupled, moved over to a new position and set up, but this need not entail stopping the pump, as the change-over can be planned to leave some lines working while others are being changed.

Nozzles. The usual spacing of the brass nozzles on the spray lines is 2-ft. apart. For outside work at a pressure of 50 lb. per sq. in., they are designed to throw a jet a distance of 20-25 ft., but for higher pressures the distance between the nozzles may be increased up to 4 ft. The lower the pressure, the shorter and coarser the jet. Up to the present, the size of nozzles has not been standardized, but manufacturers are able to specify the capacity of their nozzles at various pressures. The general capacity is about 7-8 gal. per hour at 50 lb. per sq. in., and a spray line of 200 ft., with nozzles of this type every 2 ft. would deliver some 750 gal. an hour over an area 16 yd. wide, i.e., roughly one-quarter of an acre. This would be equivalent to an inch of water in 8 hours.

For glasshouse use special nozzles are made to give a short, fine jet.

Stepped Lines. Where water pressure is low and the spray lines are long, it may be necessary to step the lines, that is, to use pipes of a smaller diameter towards the ends farthest from the main.

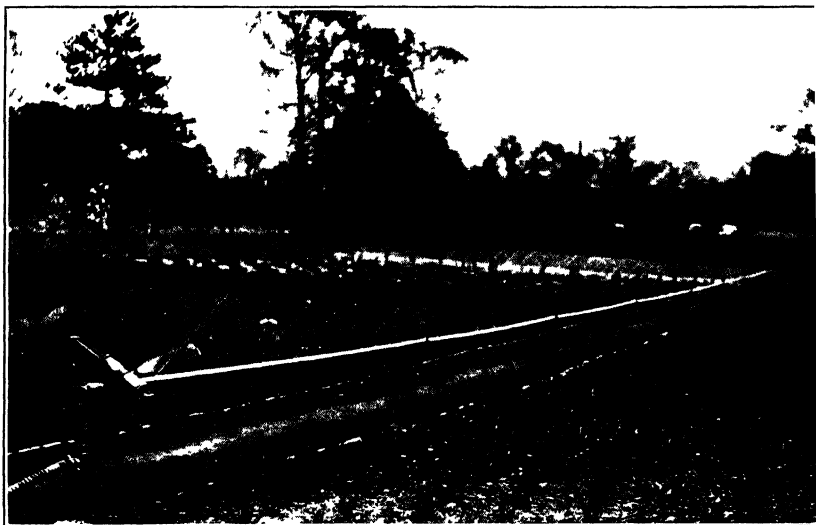
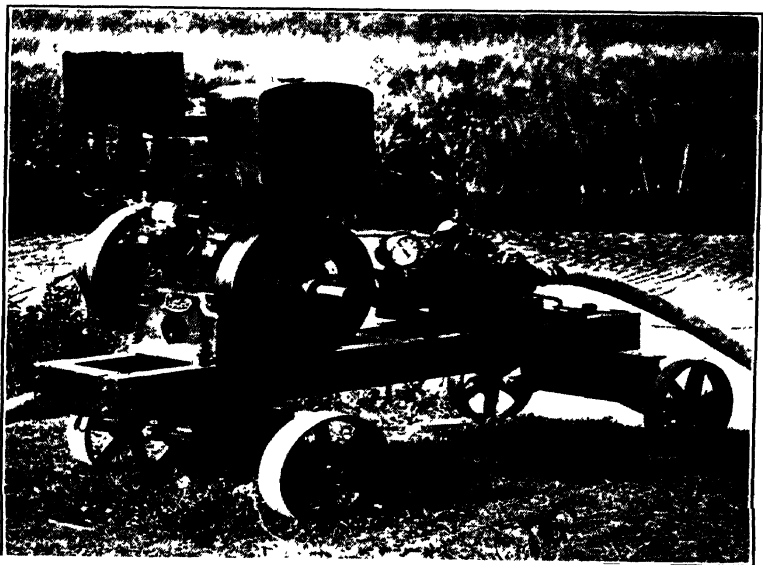


FIG. 1. A portable spray line in use on market-garden crops, showing automatic oscillator



FIG. 2. A 4 inch main with spray lines used on cauliflower, lettuce in foreground
(Photographs by courtesy of the "Farmer and Stockbreeder")

To face p. 172.



portable pumping outfit for use with
overhead irrigation



Fig. 4 A 600-feet, stepped, portable spray line on high
permanent supports, fitted with hand-operated turning device

OVERHEAD IRRIGATION

Filters. To avoid fouling the nozzles, a cone-shaped filter is inserted in the line either separately or in combination with the turning union. A removable stop end or a flushing valve is also used at the end of the spray line, so that dirt accumulating in the pipe may be periodically washed out. The flushing valve operates each time the water is turned on by allowing the first flush of water to escape, the valve tightening up only with the increase of pressure.

Operation of the Plant. Before starting up the pumps, it should be ascertained that all end stops are in place, that all nozzles are correctly pointed and that the valves to the spray lines are open. The turning on of the water on systems supplied from town mains should be very gradual.

Circular Sprays. In these, a rotating nozzle casts a jet over an area of some 50-ft. diameter. Their chief drawback is the irregularity of watering on areas greater than that covered in a single application, for if the apparatus is moved so that the circles of application only touch, some land is left unsprayed, while overlapping of the effective circles entails localized overdosing. Some use is made of this type in fruit plantations in the U.S.A., and on agricultural crops in Germany.

Pumping Plant. Centrifugal pumps driven by electricity or an internal combustion engine are considered the most efficient for spray irrigation purposes, being capable of dealing with large quantities of water at high pressures. Where the water supply is from a deep well, two pumps may be necessary, one a low-pressure pump, possibly of the air-lift type, for raising the water to a reservoir at ground level, and the other to serve the mains and spray lines at high pressure.

Spray Irrigation on Various Soils. The soils that respond best to spray irrigation are light sandy loams and brickearths on gravelly subsoils. On these there is little risk of puddle formation; the pipe lines, therefore, require the minimum of turning, and the spray need not be over-fine. Turning the direction of the nozzles three or four times so that they remain stationary for about two hours in each position should be adequate. Heavy clays are seldom suitable as on them

OVERHEAD IRRIGATION

puddles may form with high-pressure fine sprays and constant oscillation of the lines. Whatever the nature of the soil, it should be rich in humus, as infertile soils cannot yield sufficiently to justify the cost of spray irrigation.

In the use of the spray for improving the working condition of the soil, a more rapid and coarser application may be given than when used on a growing crop. The equivalent of 1 in. of rain may be given, and this not only makes the soil workable for seed sowing, etc., but provides a reserve of moisture that may be sufficient to maintain some crops, e.g., lettuce, to maturity with further watering.

It will be evident that with an irrigation system the programmes of cultivation will require adjustment, as, unlike rainfall, which usually is accompanied by dull weather, the spray is often given in hot sunny periods, and cultivations must be hastened to forestall the loss of moisture.

There is some difference of opinion on the question of watering before or after ploughing on dry soils that require deep cultivation prior to seeding or planting. As a general rule, light open soils may be watered after ploughing, and heavy soils, such as alluvial silts, beforehand. If farmyard manure is to be applied to these heavy soils, it should be spread before watering, and cultivation must follow as soon as the soil texture will permit, followed by seeding or planting; it is important not to irrigate more land than can be dealt with conveniently without loss of moisture.

If farmyard manure is not available, a mixture of 8 cwt. hoof-and-horn meal, 4 cwt. bone meal, and 1 cwt. sulphate of potash per acre may be used, with a possible increase of the potash on very light soils.

The sodden manure is drawn into the furrows during ploughing, which should be to a depth of 9 in., with subsoiling to a further 6 in. The land is then rolled with a light wooden roll (compression of the soil by heavy steel rolls leads to excessive evaporation), followed by the seed harrow. Tractors should not be used, and all carts should be fitted with pneumatic tyres.

The effects of hot, dry weather following seeding may be counteracted to some degree by a light rolling, and excessive soil heating may be reduced by spreading hydrated lime at the rate of 10 cwt. per acre.

On soils cultivated before watering, the manure is ploughed in and the land harrowed. About 24 hours after watering,

OVERHEAD IRRIGATION

or as soon as a light cultivation becomes possible, a further harrowing is given.

With irrigation, the response to normal systems of manuring varies very considerably, and many questions, particularly those regarding the availability of phosphates, require investigation.

Irrigation of Growing Crops. There are no rule-of-thumb methods; times and quantities must be based on observation of the needs of the plants and of the state of the soil. A crop may be damaged by untimely overhead irrigation. The danger of leaf scorch can, however, be obviated by watering in the evening, at night or early morning.

The usual quantity given at a single application is about 12,500 gal. per acre, equal to $\frac{1}{2}$ in. of rain, which can be given in four hours at a pressure of 50 lb. per sq. in. with small aperture nozzles set 2-ft. apart on spray lines 50-ft. apart. On very dry soils, 6-7 hours of such irrigation may be given. The surface soil should always be hoed as soon as convenient after watering.

Rapidly growing crops, such as cauliflower, will require under drought conditions an application every 10-14 days. These waterings should be given in sunless periods, and, if the curd has formed, only at night, or early morning. The same caution applies to lettuce that is likely to dry out before cutting, but the equivalent of $\frac{1}{4}$ in. of rain is sufficient for this crop.

With most other crops, beet, sprouts, cabbages, etc., the risk of damage is very much reduced, but overhead watering has a deleterious effect on seakale, and it is said to encourage canker in parsnips.

Costs. Excluding pumping plant and mains, the cost of spray lines, supports and connexions sufficient to irrigate one acre at a time amounts to about £75-80.

REGRAFTING FRUIT TREES BY FRAMEWORK METHODS

R. J. GARNER,

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The Development of Frameworking. The method of regrafting mature trees involving the retention of the framework branches is not altogether of recent introduction. As far back as 1813, Thomas Andrew Knight described the frameworking of pear trees and said: "The tree extended as widely in the autumn, after it was grafted, as it did in the preceding year. The grafts were also so disposed, that every part of the space the tree previously covered, was equally well supplied with young wood." This description serves equally well for frameworking as practised to-day.

Frameworking on a commercial scale has only been in use within the last ten years or so, first in Tasmania and on the Australian continent and later in almost all the major fruit areas of the Empire. In 1931, Dr. R. G. Hatton, Director of East Malling Research Station, had an opportunity of studying frameworked trees in Tasmania, and upon his return to England suggested to the writer that frameworking might prove useful in this country. Trials were therefore started in 1932 at East Malling to test the practicability of the method. The first trials were confined to apples and the shield-bud method was used. The tree was prepared by removing all small lateral branches and spurs from the framework of the tree in the winter. Numerous shoots arose from the framework and these were budded in August with the desired variety. Framework budding has the advantage of economizing scion material, but its numerous drawbacks in other directions preclude its employment in commercial fruit growing. A year passes whilst suitable stock shoots are being produced on the denuded framework and the single growth arising from the inserted bud is often very vigorous, resulting in delay in the production of fruiting wood.

In April, 1933, various methods of grafting with dormant scions were tested, and it was at this time that the stub-graft

FRAMEWORKING FRUIT TREES

was first employed in frameworking. Before this time methods of grafting in frameworking had involved the use of some material such as raffia, soft string or waxed cloth for holding the scions in position until a union was effected. The inverted L bark-graft was fixed by a small nail or gimp pin. Side-cleft grafts, which require neither tying nor nailing, were not developed for frameworking until after 1933.

Of the methods of grafting used to-day in frameworking, only the inverted L bark-graft requires fixing by artificial material. All the others, such as the stub-, side- and awl-graft, are held by the tree itself. It is essential that frameworking technique should be simple and easily learnt because, where the work is at all extensive, a large team of workers must be employed and not just one or two expert grafters.

The Advantages of Frameworking. There are two main advantages gained by frameworking as against topworking. First, the retention of the main branches in their entirety helps to maintain a normal balance between root and shoot; consequently, the health of the tree is not impaired. The formation of large wounds is avoided and the small wounds are quickly healed. Quite often the formation of large wounds, by the removal of the main limbs of the tree, is followed, sooner or later, by the death of the tree, and in such cases frameworking has proved to be the only method of reworking that is possible. A topworked tree which has succumbed to disease is shown in Fig. 1. The second, and usually the most obvious, advantage is that frameworked trees very quickly return to profitable cropping. It has been reported that trees have returned to heavy cropping in the second season after grafting, but in England full cropping does not return until the third season. Fig. 2 depicts an apple tree carrying five bushels of fruit in 1937 following frameworking in 1935. In retaining the framework of the tree almost all the growth from the new scions goes to form fruiting wood, whereas in topworking a new framework has first to be produced to carry new crops, and this may require many years.

Methods of Frameworking. Methods of frameworking may be separated into two: (a) cleft-grafts and (b) rind-grafts. All forms of rind-graft entail the separation of the rind from the wood of the tree, and in normal seasons in England this is not readily accomplished until April. Cleft-

FRAMEWORKING FRUIT TREES

grafting does not entail the separation of rind and wood, and may therefore be practised with success from February to May inclusive. The cleft-graft methods advocated are the stub- and the side-graft. The rind-graft methods advocated are the inverted L bark-graft and the awl-graft, sometimes termed the needle-graft.

SOME ESSENTIALS TO SUCCESS IN FRAMEWORK GRAFTING.

Condition of Scion. It is important to ensure that the scion-wood is less advanced in growth than the stock or tree, and this is accomplished by collecting it whilst completely dormant, preferably before the end of January, and storing it in a cool moist place until the time of grafting.

Length of Scion. The length of the scion is of the utmost importance. During the first season after grafting scion growth is usually very vigorous, and when short scions of three or four buds are used each bud develops into a strong shoot devoid of fruit buds. This type of growth, though desirable in ordinary topworking, is undesirable in frameworking, where the idea is to refurnish the existing framework with a new bearing surface. When scions of six or eight buds are used, wood growth is usually confined to the upper buds of the scion, and the lower develop into flower buds which soon come into cropping. The long scion should always be used in frameworking apples and pears.* For plums and cherries, which bear largely upon the young wood, it would seem that nothing is to be gained by the use of long scions, since shorter ones give rise to the required growth. Cleft-grafts, such as stub- and side-grafts, have proved to be more successful on stone fruits than the rind-grafts.

Spacing of Scions. Experience has shown that apples and pears may be satisfactorily frameworked with scions from eight to ten inches apart. Plums and cherries appear to require fewer scions than apples and pears, and these scions may safely be placed somewhat wider apart.

Position of Scions. Great care is necessary in placing the grafts in suitable positions. Scions placed near the crutch of the tree do not develop satisfactorily into fruit-bearing wood and it is advisable to place the first scions at least eighteen inches from the crutch of the tree. Grafting should begin low down and continue outwards from the middle of the tree, the scions being placed alternately on two adjacent

* A possible exception is the apple, Worcester Pearmain, which often fails to develop the lower buds on the scion.



FIG. 1.—A "Newton Wonder" apple tree topworked in 1935, at 13 years old, with "Laxton's Superb". Photographed in September, 1938, by which



FIG. 2.—A "Newton Wonder" apple tree frameworked in 1935, at 13 years old, with "Laxton's Superb".



FIG. 3. A 20-year old "Gladstone" apple tree, photographed immediately after frameworking with 120 scions of "Worcester Pearmain".

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boughs. Higher up, the boughs are more widely separated, and there is less danger of inadvertently damaging grafts whilst placing further scions on the tree. Scions in a vertical position, especially on the inner and top surface of the limb, make stronger growth than those approaching a horizontal position. Very vigorous growth is not needed except where an extension branch is required. Scions on the underside of the limb and in a horizontal position produce the weakest growth. An even scion distribution designed to obtain even vigour comparable with that of a normal tree is to be preferred. Positions on the upper or inner sides of the limbs should be avoided, as here growth is almost certain to be too vigorous. Neither should scions be placed low down on the outside of the tree where they may be damaged by cultivators. In selecting the position for each scion, first consideration should be given to its effect on the future growth of the scion rather than to ease of manipulation at time of grafting.

Where stub-grafts alone are used there is a risk of having stubs on one side of limbs only. This encourages an unnatural and one-sided development. Stub-grafts should only be used where the position is suitable and the gaps should be filled in with side-grafts. Fig. 3 depicts an apple tree which has been suitably frameworked.

The Stub-graft. *Preparing the Tree.* The tree to be grafted is cleared of all lateral growths under $\frac{1}{4}$ in. or over 1 in. in diameter. Small lateral branches between a quarter and one inch in diameter are retained wherever it is desired to have lateral branches of the new variety. This work may be carried out at any time during the dormant season or immediately before grafting. In order to avoid trouble from the "Silver Leaf" fungus (*Stereum purpureum*) it is considered advisable to delay cutting the tree until grafting time. The main limbs should not be shortened when preparing the tree.

Preparing the Scion. The scions are cut with their basal ends in the form of a wedge (Diagram 1A). One side of the wedge receives a slightly longer cut than the other. The position of these cuts relative to the basal bud of the scion appears to be unimportant. The lateral branch to be grafted receives a cut on its upper side, beginning half-an-inch or so from the main branch and extending to the base and almost to the centre of the lateral shoot. Care must be taken to

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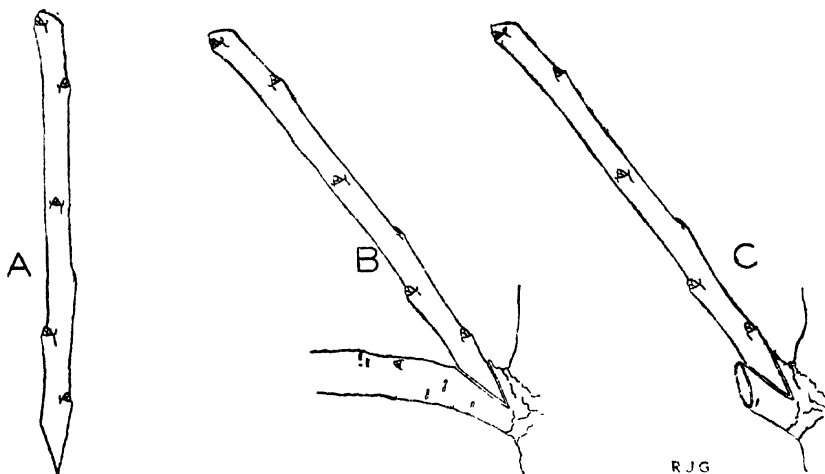
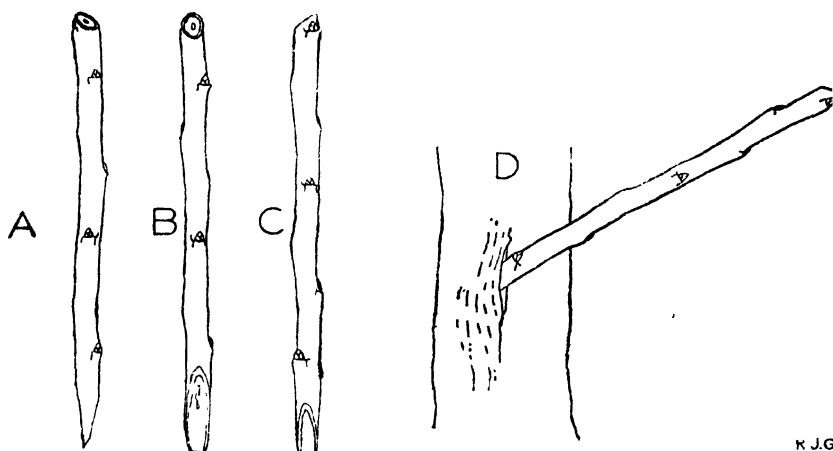


DIAGRAM 1 —Stub-grafting.

ensure that the cleft does not extend beyond the centre of the shoot, otherwise the "spring" of the lateral will be weak and the scion will not be held firmly.

Inserting the Scion. The cut is opened by bending the lateral down, and the base of the prepared scion is inserted with the longer side of the wedge downwards (Diagram 1B). When inserting scions into laterals which are considerably thicker than the scion it is necessary to match the cambiums by placing the scion towards one side of the cleft. If the cleft is not horizontal the scion should be matched on the higher side. The rind of the lateral shoot is likely to be considerably thicker than that of the scion, and it is important to remember in all methods of grafting of this type that the inside of the two rinds must match and not the outside. Having released the lateral, after inserting the scion, it is cut off immediately above the inserted scion (Diagram 1C). Upon first attempting this operation some difficulty may be experienced, but with a good knife and after a little practice, it can be satisfactorily accomplished. Some operators use secateurs, but a knife is preferable. The terminal shoot on each main branch is cut off, at the time of grafting, at a point immediately above the uppermost stub-graft. The sealing of all cut surfaces completes the operation.

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DIAGRAM 2 —Side-grafting

The Side-graft. Here scions are inserted direct into the limbs of the tree without recourse to the use of lateral shoots. Small limbs are more easily side-grafted than those of large size.

Preparing the Tree. The tree is prepared by removing all the lateral shoots before grafting, and the whole framework is then worked with side-grafts. Alternatively, the best placed laterals may be left in and stub-grafted, in which case only the intermediate portions of the limbs are furnished with side-grafts.

Preparing the Scion. In preparing the scions, advantage should be taken of the slightly "zig-zag" nature of the shoots in order that the scion, when inserted, may stand away from the framework branch as much as possible, so that the angle between the scion and branch resembles that between a lateral and the branch which bears it. This is attained by making the first, and principal, cut at the base of the scion from just above a bud in a slant of one inch or more in length through the scion. The weak point at the base of the scion is removed by a cut on the opposite side of the scion, and a further shallow cut is also made on this side to expose the cambium. The prepared scion is depicted in Diagram 2A, B and C.

Inserting the Scion. A cut is made into the side of the

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branch, at an angle of about 20° , never deeper than one-quarter of the diameter of the branch. The cut is opened by slight bending of the branch and the scion is inserted so that its cambium is in contact with that of the framework. The thin lip of bark, which contains no cambium, raised from the branch prior to inserting the scion, is cut off after the scion has been pushed home. (Diagram 2D.) To complete the graft, it only remains to seal the exposed cut surfaces.

Oblique-Side-grafting. A modified method of side-grafting, known as the oblique-side-graft, originally developed in Tasmania, has proved a success at East Malling.

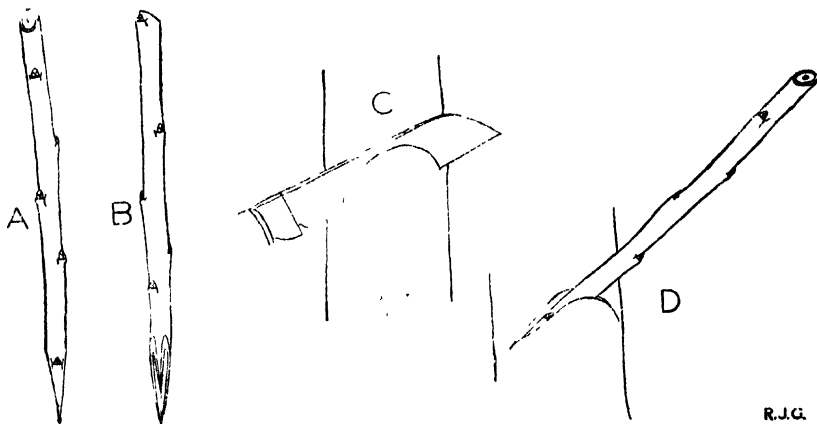


DIAGRAM 3 —Oblique Side-grafting.

Preparing the Scion. The scion is prepared as in Diagram 3A and B, with two sloping cuts about one inch long made on two sides of the bud at the basal end of the scion, in such a manner that the two cuts meet longitudinally on one side at an angle of $30-45^{\circ}$.

Inserting the Scion. A shallow oblique cleft is made in the side of the limb as in Diagram 3C. This cleft should be slightly deeper than the lateral wedge at the base of the scion, so that the cambium of the scion may match the cambium beneath the thick bark of the limb. The knife is partly withdrawn from the cleft to allow the toe of the scion to be inserted, the knife is then removed and the scion wedge is pushed right across the cleft. The thin edge

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of the bark, raised from the limb by inserting the scion, contains no cambium, and may be pared off before sealing the graft. The oblique-side-graft is only practicable on comparatively large limbs. It is particularly suitable where the rind of the limb is very thick.

The Inverted L Bark-graft. Bark-grafting can only properly be done when the bark or rind is lifting freely. All lateral shoots and spurs are removed from the tree before grafting begins.

Preparing the Scion. The scion is prepared by first making

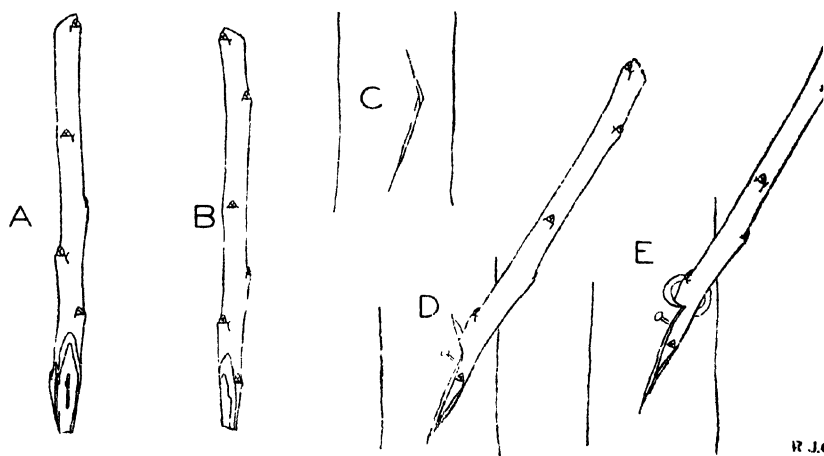


DIAGRAM 4 --Inverted L Bark-grafting

one sloping cut similar to the first and principal cut described for the side-graft (Diagram 2A) taking advantage of the "zig-zag" nature of the scion. This is followed by a very shallow cut at one side just sufficient to expose the cambium (Diagram 4A). The scion is then reversed and a smaller and shallower cut than the first is made a little to the side of the scion away from the small second cut (Diagram 4B).

Inserting the Scion. The limb to be grafted now receives a cut as depicted in Diagram 4C. The term "inverted L" does not accurately describe this cut. In the diagram it will be noted that the longer, or lower, cut is not made in line with the limb, as this would cause the scion to lie along the

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limb at an unnatural angle, but it is so made that the scion stands away from the surface of the limb. The top cut is not made at right angles with the lower, but more nearly approaches 150° . It is also cut obliquely into the bark, thus enabling the scion to enter beneath the bark more easily and to fit snugly into position. The scion is inserted and pushed down under the bark so that the principal cut on the scion rests upon the wood of the limb, and the raised bark overlies the cut frontal surface of the scion (Diagram 4D). The trimmed edge of the scion rests firmly against the edge of bark made by the longer and lower cut on the limb. The cuts in the limb should always be made as shown in the diagram, or its mirror image, so that water running down will tend to overshoot the graft and not collect at that point. The scion is held firmly in position by a flat-headed nail, or gimp pin, of No. 19 gauge and $\frac{5}{8}$ in. long, which is driven right home through the bark and scion into the wood. When the bark of the limb is abnormally thick, $\frac{3}{4}$ in. nails of the same gauge are used. Scions placed immediately below wounds (Diagram 4E) caused by the removal of lateral shoots or spurs assist the rapid healing of the wounds, moreover, the sealing of the graft seals the wound, thus saving both time and material. In sealing this type of graft, which forms a narrow angle with the limb, it is especially important to ensure that water cannot enter between scion and limb.

The Awl-Graft or Needle-Graft. It is somewhat doubtful

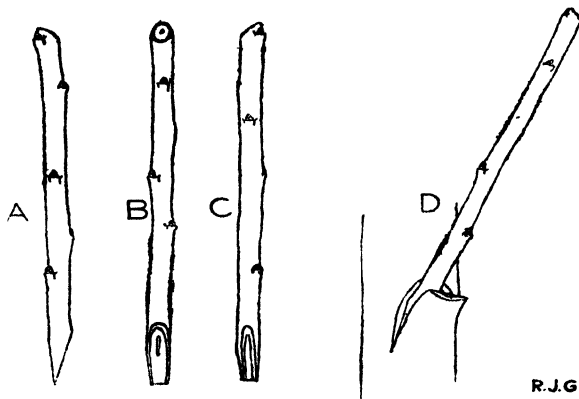


DIAGRAM 5.—Awl-grafting.

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if this method will eventually prove so satisfactory from the point of view of neatness and strength at the union as the methods already described, but it is certainly very easy to carry out, except on very thin branches. The tree is denuded of laterals as for inverted L bark-grafting.

Preparing and Inserting the Scion. The scions are prepared as shown in Diagram 5A, B and C. A chisel-bladed tool is now inserted through the bark and between it and the wood of the limb to be grafted. The tool should enter the bark at an angle of some 20° to 30° above the horizontal, and be pushed about $\frac{1}{4}$ in. under the bark around the limb, just sufficient to raise the bark. The base of the scion is inserted immediately behind the tool, which is then removed, and the scion is pushed firmly beneath the bark until the whole cut surface is out of sight. All cut surfaces and cavities are sealed.

Various tools have been used for awl-grafting. One of the best is that made from a small screw-driver which has been slightly bent towards the tip. Another is made from a sacking needle by grinding the point away to a chisel end and fixing the eye end of the needle into a convenient handle. Other suitable tools may be improvised according to the fancy of the operator.

The terminals of the limbs of trees frameworked by rind-grafting methods, such as the bark- and awl-grafts described above, may be rind-, cleft-, stub-, side- or whip-and-tongue-grafted to complete the work.

Graft Seals and Wound Dressings. Perfect sealing of grafts is of the utmost importance, as a large proportion of failures may be attributed to inefficient sealing. Suitable materials for sealing framework grafts are hot grafting wax, certain bitumen emulsions and various grades of petroleum jelly. The stub- and side-grafts are best sealed with waxes or mastics which set firmly like cement. This does not apply to the rind methods described. Hot waxes are generally made by the grower, but can be purchased. Emulsions, jellies and the like are purchased ready for use. Materials should not be used for sealing grafts on a large scale until they have been thoroughly tested, since serious damage has occasionally occurred where seals containing artificial driers and water-proofing materials have been applied to grafts.

Subsequent Treatment of Frameworked Trees. *Removal of Sucker Shoots.* As the season advances, sucker shoots will

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arise from the main branches of the old variety. These should be rubbed out when the longest are between three and six inches in length and whilst they are still soft and green. At this time most of the sucker shoots likely to arise in the first season can be removed, and it may not be necessary to remove any more until the first winter pruning. Where sufficient scions have been used, very few sucker shoots will arise in later years.

Pruning. Where the trees are in exposed positions, or where prodigious growth has occurred, it may be advantageous to shorten the longest growths by one half their length in July or early August to lessen the danger of blowing out during windy weather. Summer pruning of newly frameworked trees has not yet been shown to hasten fruiting. Where trees are growing on clay soils it appears to be worth while, during the first growing season, to stick handfuls of clay towards the tips of shoots on the outside of the tree to depress them and, by so doing, hasten the formation of fruit buds along the shoots. Those intended for leaders should not be so treated.

For the first few years after grafting, the main object of winter pruning is to regulate the growth of the vigorous new shoots, to preserve a suitable tree form, without delaying the early return to cropping. At the first winter pruning, shoots chosen for leaders may be shortened to half their length. Lateral shoots on the outside of the tree are left unpruned. On the inside of the tree, shoots suitably placed for fruiting may be shortened to not more than half their original length. No spurring of shoots should be allowed. Crossing and crowded shoots should be removed entirely. In doing this it is often possible to joint back to the second shoot on the scion, leaving this second shoot entirely alone or only very lightly tipped.

At the second winter pruning, the leaders are treated as before. Unpruned laterals on the outside of the tree should now be showing fruit buds and may be shortened a little. The removal of a few inches back into the two-year wood is often enough. Laterals which have arisen on the shoots left last season may be long spurred. Shoots on the inside of the tree, shortened last season, should have formed a few fruit buds. Two or more shoots may have been produced and the upper ones may be conveniently removed by jointing back to the lower. This in turn may be long spurred or left, according to vigour. The following season should see the

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tree in full cropping, and in subsequent years it should be possible to follow the normal pruning for the particular variety.

Costs. The cost of frameworking depends largely upon the number of scions, size and shape of tree and the amount of ladder-work. This latter may be reduced by the intelligent use of a trolley or van upon which the workers may stand, so that they can conveniently reach the branches from a firm support.

Costs vary very much, but any figure not far above 2s. 3d. per 100 scions, inclusive of everything except cost of scion wood, should be regarded as satisfactory. Some few growers have kept costs as low as 1s. 6d. per 100, but only where conditions are very favourable.

An outstanding feature of fruit from newly frameworked trees is its uniformity of size and shape. On the other hand, fruit from newly topworked trees is often of poor quality and, at the same time, there is a wide range of size and shape.

Frameworking is now practised on a very large scale in England. Some growers have already successfully frameworked many hundreds of trees, principally apples and pears. At least one grower has inserted over three hundred thousand scions by framework methods.

Those wishing to read more details relative to the subject of frameworking may refer to *The Frameworking of Fruit Trees*, by R. J. Garner and W. F. Walker, published by the Imperial Bureau of Horticulture and Plantation Crops, East Malling, Kent, price 1s., post free.

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Insect Attack on Grain and Stored Produce

The infestation of grain by insects and other pests is in no way mysterious, but only happens when the insects invade the grain from outside. The opinion that grain itself generates weevils or other insects is entirely wrong. Over 150 different kinds of insects have been found in grain or grain stores, but only a few of them cause serious damage. Of these the most important are the grain weevils, the flour moths and the flour mites. The grain weevils are small, dark-brown beetles with pronounced snouts; the moths are not unlike the common clothes moths, while the mites are tiny animals almost invisible to the naked eye except when they congregate together. It is not the size of the insects but the rate at which they multiply which causes the trouble. In the course of a year, a single female weevil may give rise to one million offspring or more, while the female flour beetle commonly lives for at least a year and lays from one to two eggs a day.

In view of the tremendous waste and spoilage due to the depredations of these insects, the protection of grain and other stored produce becomes a problem of growing urgency in national defence. In close co-operation with the industrial interests concerned, the Department of Scientific and Industrial Research has arranged for research on the practical aspects of the problem, and work is being carried out on behalf of the Department by Professor J. W. Munro, assisted by a team of entomologists, chemists, botanists and physiologists.

Last year, Professor Munro made a survey of the extent of insect infestation of stored grain and grain products in this country. The survey disclosed an unexpected lack of know-

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ledge of the principles of simple warehouse hygiene, and to assist all concerned in the storage of grain the Department has issued a brief pamphlet on the subject ("Pests of Grain," published by H.M. Stationery Office, 3d. net). This describes the most common grain pests and simple but effective means for keeping them in check.

Insects and mites increase in numbers only when they have an undisturbed food supply and breeding ground. Obviously, therefore, neglected heaps of old grain or feeds, sweepings, old sacks, and long-accumulated debris in corners and in cracks between floorboards form ideal breeding grounds for them; and the first step in the war against these pests is to see that such breeding grounds are not allowed to remain.

It may happen, however, that as a result of long neglect or the occurrence of the unfortunate arrival of an unusually heavily infested consignment, the precautions described in the pamphlet to remove the risk of infestation may be insufficient; it then becomes necessary to use other methods, such as fumigant gases or insecticidal sprays. Some of these methods are already fully developed but others require further investigation on the scientific or the commercial side, and this work is being undertaken. The pamphlet states that:

Except for small-scale work, such as fumigation of corn or flour bins or of small parcels of empty sacks, fumigants should be used only by skilled operators. Advice on fumigation can be obtained from a number of professional fumigation firms operating in this country or from the Director of the Stored Products Research Laboratory, Imperial College of Science and Technology, Slough, Bucks.

A chart suitable for hanging in warehouses or barns, summarizing the information in the pamphlet, has also been prepared and can be obtained from Stationery Office Sales Offices at the cost of 4d. (post free 6d.).

Wild White Clover Certification Scheme

The value of Wild White Clover in temporary leys and in seeding land down to permanent pasture receives increasing recognition each year, and there is a steady demand in this country for certified seed, which usually commands a small premium over the price of uncertified seed.

Farmers are reminded that, in accordance with the Wild White Clover Certification Scheme operated jointly by the National Farmers' Union and the Ministry, applications for

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the inspection of pastures must be completed and approved for submission to the Ministry by May 15.

Two classes of fields are eligible for recording, viz., Grade A and Grade B. Grade A refers to genuine old pastures of ten or more years of age, which have not been renovated during that time with wild white clover seed, and Grade B refers to pastures of less than ten years of age, which have been grown from seed obtained from a genuine "old pasture."

The fee for inspection, which is the only cost to the grower, is 2s. per acre for the first ten acres (with a minimum charge of 10s.), and 1s. per acre afterwards. Once a field has been recorded as suitable for the production of genuine wild white clover seed, application can be made for an official certificate, which is issued free of charge, in respect of the crop harvested. This certificate, or its reference number, can be passed on or quoted in respect of any sale of the seed. Farmers who wish to sow certified seed should insist on receiving the certificate number of the lot offered. A claim that the pasture from which the seed offered has been "inspected" does not necessarily mean that it has been approved and recorded.

Forms of application and full particulars may be obtained from any County Secretary of the National Farmers' Union, or direct from the Secretary of the Central Wild White Clover Committee of the National Farmers' Union, 45 Bedford Square, London, W.C.1. Farmers who are not members of the National Farmers' Union are eligible, and may obtain forms of application and information from these sources.

Importation of Raw Vegetables

The present regulations under the Importation of Plants Orders of 1933 to 1938 require raw vegetables imported into this country after April 7 to be accompanied by certificates from the country of origin.

After consideration of the latest technical information regarding the habits of the Colorado Beetle in Europe, it was decided that the period during which raw vegetables might be admitted without special restrictions could be extended, and a General Licence was signed on April 1 under which raw vegetables (other than potatoes) might be landed without certificates up to April 20 inclusive.

The question of the modification of certain other restrictions

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embodied in the Importation of Plants Orders is at present under consideration, and a further announcement will be made shortly.

Boar Licensing

A conference was held at the Ministry on March 27, 1939, to discuss the desirability or otherwise of introducing a scheme of boar licensing in Great Britain. A full exchange of views took place, and, while several speakers made it plain that the organizations or societies* which they represented had not formally expressed any views on the subject, there was a general consensus of opinion among those present that a system of boar licensing, with proper safeguards, on the lines of the bull licensing scheme which has now been in operation in England and Wales for nearly five years, would bring about a widespread improvement in the general standard of pigs, whether bred for bacon or for pork, thus benefiting all sections of the pig industry, i.e., producers, breeders, marketing organizations, meat traders, etc., as well as the consuming public.

Tripod Harvesting

The use of collapsible metal tripods in harvest fields has much to commend it in the uncertain climate of this country. Although tripods have been in use for many years, the collapsible ones with special venting devices are a more recent introduction, and by their use it is possible to obtain adequate ventilation through the centre of the cocks, thus ensuring even drying of the crop.

Sheaves can be built around the tripod immediately after cutting; during a wet harvest it is comforting to know that the corn is then safe from weather damage and that it can be left to dry and await a suitable moment for carrying. Even in a dry year it may be convenient to use tripods and cut as

* The conference was attended by representatives of the National Farmers' Union, the National Farmers' Union and Chamber of Agriculture for Scotland, the Royal Agricultural Society of England, the Highland and Agricultural Society of Scotland, the Bacon Development Board, the Pigs Marketing Board, the Bacon Marketing Board, the National Pig Breeders' Association, the British Pig Producers' Council, the Cumberland Pig Breeders' Association, the Large Black Pig Society, the Essex Pig Society, the National Long White Lop-Eared Pig Society, the Gloucester Old Spots Pig Breeders' Society, the Welsh Pig Society, and the National Federation of Meat Traders' Associations.

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large an acreage as possible whilst good conditions last; stacking or threshing can be done later since the crops have been made safe.

Once the sheaves have been built on to the tripods they need no further handling until they are threshed or stacked; the entire cock, including the tripod, can then be picked up on a low-loading tip cart, or ricklifter, and taken to stackyard or threshing drum.

Two men with a tractor and ricklifter should be able to bring the cocks in sufficiently quickly to keep a threshing set supplied, unless the distance is great.

In some seasons it may be desirable to leave the crop to condition on the tripods whilst the land between the lines of cocks is ploughed; most of the acreage can thus be broken in good time, leaving only a small part to be dealt with after the crop is carried.

This method of harvesting should be of interest to those who grow crops of corn specially for seed, for it preserves the colour of the grain since the ears are saved from discoloration due to weathering.

In the hay field a better quality fodder is procured when the crop is cured on tripods on account of the steadier drying, damage from either sun-scorch or rain being avoided.

An ingenious user will find that tripods can be of assistance in the getting of special crops; they have been used, for instance, for the barn drying of clover for seed, and other applications will doubtless suggest themselves.

Although in the field the building of cocks on to tripods may require a little more labour than do the usual methods, this is off-set by the smaller number of men required to carry the crop when it is fit; in fact it is claimed by some that by reason of the saving of labour and the better quality of the product the tripods pay for themselves in one year.

Visits to Rothamsted and Woburn Experimental Stations

Farmers and all interested in agriculture in its practical, technical, or educational aspects are cordially invited to visit the Rothamsted and Woburn plots at any convenient time between the beginning of May and the end of October. Mr. H. V. Garner, M.A., and Capt. E. H. Gregory will be in charge of the demonstrations. There is ample material

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at each farm to occupy a full day, and therefore visitors should arrange to see them on separate days.

Rothamsted. The soil is a heavy loam. The classical fields, laid down from 1843 onwards, form an unequalled demonstration of the effects of fertilizers on wheat, barley, mangolds and meadow hay. The continuous growing of wheat on Broadbalk field is of special interest to those who are now faced with the manurial and cultivation problems arising out of mechanized cereal farming. Modern fertilizer and cultivation problems are being investigated by the new field technique developed at the Station.

These modern experiments are concerned with the manuring of potatoes, sugar-beet, wheat, barley, mangolds, beans, flax, oats and clover. Rotation experiments test various alternative methods of returning cereal straw to the soil. The production of the farmyard manure for these experiments is made to yield data on the losses of nitrogen and organic matter involved in making dung in covered boxes with different amounts of litter.

Additional experiments deal with the best crops and manurial treatment to follow ploughed-out grassland with special reference to wireworm attack; other experiments are concerned with the effects of bare fallowing and rotary cultivation. Tests of soil fumigants against insect and other pests are in progress. Quantitative tests are in progress on the performance of different sizes and weights of rubber tyres on farm tractors. Grazing trials on the effect of cake feeding on pasture are in progress, and a study of methods of fertilizer placement is being made. The Rothamsted farm is supplied with a complete range of electrical equipment.

Woburn. The farm is on light soil. In addition to the classical fields, modern experiments are in progress on potatoes, barley, sugar-beet, kale, carrots, lucerne, and straw and green manure crops. A new long-period experiment comparing rotations based on 3-year leys with purely arable systems has been started.

The Director, Sir John Russell, will be happy to arrange full details with organizations of farmers, farm workers and others wishing to accept this invitation; small groups of farmers are specially welcomed. If possible, arrangements should be made beforehand; but it is recognized that farmers' movements must often depend on the weather, and no farmer need stay away because he has been unable to write fixing a date.

All communications and requests to visit the Stations should be addressed to the Secretary, Rothamsted Experimental Station, Harpenden. It would be a convenience if ample notice could be given so as to avoid the possibility of dates clashing.

Eighteenth Annual Congress of Agriculture

This Congress will be held in Dresden on June 6-12. The organizing body is the International Federation (formerly Commission) of Agriculture, which has a permanent office in

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Paris. The forthcoming Congress is the first to be held in Germany.

The programme is as follows:

Agrarian Policy and Farm Management. Rural depopulation, effect of changes of diet, land improvement.

Agricultural Instruction and Propaganda. Education, extension work, agriculture in schools, broadcasting and films.

Agricultural Co-operative Societies. Production, processing, trade.

Cultivation of Plants. Colorado Beetle, virus diseases, soil research.

Vines, Fruit-growing and Special Plants. Production of fruit and vegetables on smallholdings.

Animal Production. Foot-and-mouth disease, breeding, public assistance, heredity, efficiency tests.

Agricultural Industries. Synthetic materials, preservation, crop drying.

Rural Life and the Work of the Countrywoman. Economic and hygienic position of the rural population, labour-saving, peasant culture and traditions.

Agricultural Science. Organization and encouragement of research, animal breeding, vitamin content of foodstuffs, new problems of agricultural chemistry.

Delegates will be welcomed from agricultural professional organizations or institutions and from technical or scientific institutions concerned with the furthering of agriculture, while persons may also take part as individual members.

The official languages are French, English, German and Italian. The membership fee is 12 Reichsmark up to May 15 and 20 Reichsmark thereafter. The General Secretary, Dr. F. Sohn, Generalsekretariat des XVIII Internationalen Landwirtschaftskongresses, Berlin, S.W.11. Hafenplatz 4, will supply further information.

Conference on Agricultural Co-operation

Following the success of the Imperial Conference on Agricultural Co-operation held at the Empire Exhibition, Glasgow, in July, 1938, and in accordance with a resolution then taken, the Standing Committee of the Round Table Conference, representing the agricultural co-operative movement in the British Isles, is organizing a British Isles Conference on Agricultural Co-operation, to be held at Aberystwyth on June 9 and 10, 1939.

An attractive programme has been arranged including the following papers: "Agricultural Marketing and the Advance of Agricultural Co-operation," by Professor A. W. Ashby; "Credit for Small Holders and Farmers," by Mr. D. Witney, of the Edinburgh and East of Scotland College of Agriculture, "Crop Drying and its Relation to the Future Supply of Feed

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for Live Stock," by Mr. E. J. Roberts, University College of North Wales; "The Relations between Farmers and their Societies," by Mr. W. H. Jones, of the University College of Wales, Aberystwyth; "What Farmers Require of Agricultural Co-operation," by Alderman T. Thomas, Llanelly and District Farmers, Ltd., and "Wool Marketing," by Mr. W. Fergusson, Scottish Wool Growers, Ltd. Excursions to places of agricultural interest will be arranged.

Full particulars may be obtained from the Organizing Secretary, Round Table Conference on Agricultural Co-operation, 10, Doughty Street, London, W.C.1.

Agricultural Research Scholarships, Studentships for Research in Animal Health and Veterinary Scholarships

Acting in consultation with the Agricultural Research Council, the Ministry of Agriculture and Fisheries and the Department of Agriculture for Scotland invite applications for the following scholarships and studentships, tenable as from October 1, 1939:

- (i) Not more than four Agricultural Research Scholarships, each of the value of £200 per annum with an allowance not exceeding £50 per annum for fees and expenses, and tenable for a period not exceeding three years.
- (ii) Not more than three Studentships for Research in Animal Health, each of an inclusive value not exceeding £300 per annum and tenable for a period not exceeding three years.
- (iii) Not more than two Veterinary Scholarships, each of the value of £200 per annum with an allowance not exceeding £50 per annum for fees and expenses and tenable for a period not exceeding four years. These scholarships are intended to enable graduates with Honours in Science to obtain a veterinary professional qualification with a view to undertaking research in animal health, and any awards made will be *in lieu* of an equal number of Studentships for Research in Animal Health.

Applications must be received not later than May 31, 1939. Nomination forms and further particulars may be obtained from the Secretary, Ministry of Agriculture and Fisheries, 10, Whitehall Place, London, S.W.1, or from the Secretary, Department of Agriculture for Scotland, 29, St. Andrew Square, Edinburgh, 2, according to the country in which the candidate resides.

Marketing Notes

Livestock Industry Act, 1937: Cattle Fund. For the financial year April, 1938, to March, 1939, payments in respect of fat cattle subsidy amounted to £4,292,248 as compared with

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£3,943,209 for the previous year. The number of beasts concerned was 1,531,462, as against 1,578,713 in 1937-38, so that the average rate of subsidy, £2 16s. 1d. was appreciably higher than in the earlier period. The revised subsidy scheme which came into force under the Livestock Industry Act in August, 1937, provided for different rates of subsidy for "ordinary" and "quality" standards respectively, the highest rate being 7s. 6d. per cwt. for home-bred animals of "quality" standard. About 64 per cent. of all cattle certified for subsidy in the twelve months April, 1938, to March, 1939, conformed to the "quality" standard.

Leaflet on Market Accommodation for Attested Stock. Leaflet No. 3, which has been issued by the Livestock Commission for the guidance of market owners, sets out the desirable features which should be borne in mind when provision of accommodation for attested stock is under consideration.

Hops Marketing Scheme, 1932: Amendments. An Order has been made under the Agricultural Marketing Acts, 1931 to 1933, approving certain amendments of the Hops Marketing Scheme. They relate chiefly to the quota provisions of the Scheme which came into operation in 1934 and which, under the Scheme as now amended, will continue in operation until March 31, 1946.

National Mark Scheme for Green Peas. Certain amendments to this scheme have been approved by the National Mark Vegetables Trade Committee. These cover the following points:—

- (a) The present requirement that the yield of shelled peas from the pods in any container must be at least 28 per cent. by weight of the total contents is superseded by a requirement that 65 per cent. by count of the pods in any container must be well filled.
- (b) Well-filled, half-filled, flat, over-mature and under-sized pods are defined and, in order to allow for variations incidental to grading, certain specified tolerances are allowed.

Effect is being given to these amendments in fresh regulations which are being made under the Agricultural Produce (Grading and Marking) Acts, 1928 and 1931.

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National Mark Publicity. Arrangements have been made for participation in the following Agricultural and other Shows during the summer:

<i>Show</i>	<i>Date</i>	<i>Location</i>
Devon County*	.. May 16-18	Axminster.
Bath and West*	.. .. 24-27	Bridgwater.
Royal Counties*	.. .. 31-June 3	Portsmouth.
Suffolk ..	.. June 1-2	Saxmundham
Three Counties*	.. .. 6-8	Worcester
Royal Norfolk*	.. .. 14-15	Diss.
Sussex County ..	.. .. 14-15	Eastbourne.
Lincolnshire .	.. .. 21-23	Bourne.
Peterborough ..	.. .. 27-29	Peterborough.
R.A.S.E.* ..	.. July 4-8	Windsor Gt. Park.
Kent County*	.. .. 12-14	Folkestone.
Great Yorkshire ..	.. .. 12-14	Halifax.
Royal Welsh*	.. .. 26-28	Caernarvon.
Royal Lancs.* ..	.. Aug 2-5	Lancaster.
Sandy and District .	.. .. 31	Sandy.

A combined Education and Marketing Exhibit, together with a separate Cinema, will be featured at the shows marked *. National Mark Exhibits and working Demonstrations of the testing, grading and packing of eggs will be staged at the other shows. At the Great Yorkshire Show, live cattle, sheep and pigs will be exhibited to illustrate the various types of animal expected to yield carcasses of the grades defined under the Ministry's scheme for the sale of live stock by Dead Weight and Grade.

In addition, a National Mark Exhibit will be arranged in conjunction with the Co-Federation of Women's Institutes at the Northumberland Agricultural Show, Newcastle-on-Tyne, July 18-20, and a National Mark Exhibit at the Aldershot Show, June 29-July 1. A bookstall will be provided at the Oxfordshire Show, May 18-20.

A special Exhibition will be opened at the Charing Cross Underground Station on May 31 and will continue until June 23. This will take the form of a descriptive diorama illustrating the National Mark.

A comprehensive range of the Ministry's publications will be on sale at all the summer shows.

APPOINTMENTS

County Agricultural Education Staff

Devonshire : Miss S. McCowen, N.D.P., as Instructress in the Travelling Poultry School. **Lancashire :** Miss D. M. Ainscough as Assistant Instructress in Poultry-Keeping. **Norfolk :** Mr. J. H. Cock, B.Sc. (Agric.), N.D.A., N.D.D., as Agricultural Education Officer. **Northumberland :** Mr. W. R. Smith, B.Sc. (Agric.), N.D.A., as Assistant Agricultural Organiser. **Sussex, West :** Mr. G. H. Beard, N.D.A., N.D.D., as Instructor in Dairying. **Warwickshire :** Mr. W. Longrigg, B.Sc., N.D.A., N.D.D., as Assistant Agricultural Organiser. **Wiltshire :** Mr. G. F. Francis, N.D.A., N.D.D., as Assistant Instructor in Dairying. **Denbighshire :** Mr. W. F. Hughes, M.Sc., as Assistant Lecturer.

PRICES OF ARTIFICIAL MANURES

Description.	Average prices per ton (2,240 lb.) during week ended April 12				
	Bristol	Hull	L'pool	London	Costs per Unit [¶]
Nitrate of Soda (N. 15½%) ..	£ 8 0c	£ 8 0c	£ 8 0c	£ 8 0c	s. d. 10 4
" " Granulated (N. 16%) ..	8 0c	8 0c	8 0c	8 0c	10 0
Nitrate of Lime (N. 13%) ..	7 7e	7 7e	7 7e	7 7e	11 4
Nitro-Chalk (N. 15½%) ..	7 10c	7 10c	7 10c	7 10c	9 9
Sulphate of Ammonia :—					
Neutral (N. 20.6%) ..	7 14c	7 14c	7 14c	7 14c	7 6
Calcium Cyanamide (N. 20.6%) ..	7 19d	7 19d	7 19d	7 19d	7 8
Kainite (Pot. 14%) ..	2 18	2 15	2 15	2 15	3 11
Potash Salts (Pot. 30%) ..	5 4	5 1	5 0	5 1	3 5
" " (Pot. 20%) ..	3 15	3 12	3 12	3 12	3 7
Muriate of Potash (Pot. 50%) ..	8 10	8 8	8 5	8 8	3 4
Sulphate (Pot. 48%) ..	10 2	10 0	9 17	10 0	4 2
Basic Slag (P.A. 15½%) ..	2 12b	2 5b	—	2 10b	3 2
" " (P.A. 14%) ..	2 8b	2 0b	2 0b	2 6b	3 3
Grd. Rock Phosphate (P.A. 26-27½%) ..	3 5a	3 0a	2 15a	2 10a	1 10
Superphosphate (S.P.A. 16%) ..	3 6k	—	3 2f	2 19g	3 9
" " (S.P.A. 13½%) ..	—	—	2 19f	2 16g	4 1
Bone Meal (N. 3½%, P.A. 20½%) ..	—	7 5	6 17h	6 12	—
Steamed Bone Flour (N. ½%, P.A. 27½-29½%) ..	4 15i	4 15	4 15h	4 10	—

Abbreviations : N. = Nitrogen ; P.A. = Phosphoric Acid .
S.P.A. = Soluble Phosphoric Acid ; Pot. = Potash.

* Prices are for not less than 6-ton lots at purchaser's nearest railway station unless otherwise stated. Unit values are calculated on carriage-paid prices.

§ Prices are for not less than 2-ton lots, nett cash for prompt delivery, f.o.r., in town named, unless otherwise stated. Unit values are calculated on f.o.r. prices.

a Prices for 4-ton lots f.o.r. Fineness 85% through standard sieve.

b Prices for 6-ton lots. Prices at Bristol are f.o.r. Bridgwater ; at Hull and Liverpool f.o.r. neighbouring works and at London f.o.r. at depots in London districts. Fineness 80% through standard sieve.

c For lots of 4 tons and under 6 tons the price is 1s. per ton extra, for lots of 2 tons and under 4 tons, 5s. per ton extra, for lots of 1 ton and under 2 tons, 10s. extra, and for lots of 2 cwt. and under 1 ton, 20s. extra.

d Delivered in 5-ton lots at purchaser's nearest railway station. For lots of 2 tons and under 5 tons the price is 5s. per ton extra, for lots of 1 ton and under 2 tons, 10s. per ton extra, and for lots of 4 cwt. and under 1 ton, 20s. extra.

e For lots of 4 tons and under 6 tons the price is 1s. per ton extra, for lots of 2 tons and under 4 tons, 5s. per ton extra, for lots of 1 ton and under 2 tons, 7s. 6d. per ton extra, and for lots of under 1 ton, 20s. extra.

f Prices shown are f.o.r. Widnes.

g Prices shown are ex works London ; f.o.r. southern rails, 1s. 3d. extra.

h Prices shown are f.o.r. Appley Bridge

i Price shown is f.o.r. Newport, Mon.

k Price shown is f.o.r. Avonmouth.

¶ These are calculated by regarding a ton as comprising 100 "units" (equa-
paris of 22.4 lb.) so that a fertilizer, for example, with 16 per cent. nitrogen contains
16 such "units" in a ton. Then, if the price per ton of such a fertilizer be divided
by the percentage figure, the deduced cost is that of a "unit" of that agent. Those
in the table above are based on London prices. (For further explanation, see
Advisory Leaflet, No. 146, "The Valuation of Artificial Manures," obtainable from
the Ministry, free of charge.)

PRICES OF FEEDING STUFFS

Description	Price per ton	Manu- rial value per ton	Cost of food value per ton	Starch equiv. per 100 lb.	Price per unit starch equiv.	Price per lb. starch equiv.	Pro- tein equiv.
	£ s.	£ s.	£ s.		s. d.	d.	%
Wheat, British	4 2	0 9	3 13	72	1 0	0.54	9.6
Barley, British Feeding	6 0	0 9	5 11	71	1 7	0.85	6.2
" Canadian No. 3							
Western	6 0	0 9	5 11	71	1 7	0.85	6.2
" Canadian No. 4							
Western	5 12½	0 9	5 3	71	1 5	0.76	6.2
" Dutch	5 17½	0 9	5 8	71	1 6	0.80	6.2
" Persian	5 12*	0 9	5 3	71	1 5	0.76	6.2
" Russian	6 3	0 9	5 14	71	1 7	0.85	6.2
Oats, English white . .	6 0	0 10	5 10	60	1 10	0.98	7.6
" " black and							
grey	6 0	0 10	5 10	60	1 10	0.98	7.6
" Scotch, white . .	6 10	0 10	6 0	60	2 0	1.07	7.6
" Canadian—							
No. 2 Western	6 5*	0 10	5 15	60	1 11	1.03	7.6
No. 3 Western	6 0½	0 10	5 10	60	1 10	0.98	7.6
" Mixed feed . . .	5 13	0 10	5 3	60	1 9	0.94	7.6
" No. 1 Feed . . .	6 7†	0 10	5 17	60	1 11	1.03	7.6
" No. 2 Feed . . .	5 18	0 10	5 8	60	1 10	0.98	7.6
Maize, American . . .	6 5	0 7	5 18	78	1 6	0.80	7.6
" Argentine . . .	6 8	0 7	6 1	78	1 7	0.85	7.6
" DanubianGal.Fox	6 3	0 7	5 16	78	1 6	0.80	7.6
" Russian	6 0†	0 7	5 13	78	1 5	0.76	7.6
" South African—							
No. 2 white flat	6 3†	0 7	5 16	78	1 6	0.80	7.6
" Benguela . . .	6 0†	0 7	5 13	78	1 5	0.76	7.6
Beans, English, Winter	6 0½	0 18	5 2	66	1 7	0.85	19.7
Peas, English, blue . .	9 10½	0 16	8 14	69	2 6	1.34	18.1
" Japanese . . .	19 10†	0 16	18 14	69	5 5	2.90	18.1
" Russian	6 10†	0 16	5 14	69	1 8	0.89	18.1
Dari	8 0†	0 8	7 12	74	2 1	1.12	7.2
Milling Offals :							
Bran, British . . .	5 15	0 17	4 18	43	2 3	1.21	9.9
" Broad	6 10	0 17	5 13	43	2 8	1.43	10.0
Middlings, fine, im- ported	5 5	0 14	4 11	69	1 4	0.71	12.1
Weatings†	5 5	0 15	4 10	56	1 7	0.85	10.7
" Superfine† . . .	5 12	0 14	4 18	69	1 5	0.76	12.1
Pollards, imported	5 2	0 15	4 7	50	1 9	0.94	11.0
Meal, barley	7 2	0 9	6 13	71	1 10	0.98	6.2
" " grade II . . .	6 10	0 9	6 1	71	1 8	0.89	6.2
" maize	6 15	0 7	6 8	78	1 8	0.89	7.6
" " South							
African	6 0	0 7	5 13	78	1 5	0.76	7.6
" " germ	6 15	0 12	6 3	84	1 6	0.80	10.3
" locust bean . . .	7 5	0 6	6 19	71	1 11	1.03	3.6
" bean	9 7	0 18	8 9	66	2 7	1.38	19.7
" white fish . . .	16 2	2 6	13 16	59	4 8	2.50	53.0
" Soya bean							
(extracted)† . .	9 0	1 12	7 8	64	2 4	1.25	38.3

PRICES OF FEEDING STUFFS (continued)

Description	Price per ton	Manu- rial value per ton	Cost of food value per ton	Starch equiv. per 100 lb.	Price per unit starch equiv.	Price per lb. starch equiv.	Pro- tein equiv.
	£ s.	£ s.	£ s.		s. d.	d.	%
Maize, cooked, flaked ..	7 7	0 7	7 0	84	1 8	0.89	9.2
" gluten feed ..	6 12	0 14	5 18	76	1 7	0.85	19.2
Linseed cake—							
English, 12% oil ..	10 0	1 2	8 18	74	2 5	1.29	24.6
" 9% " ..	9 7	1 2	8 5	74	2 3	1.21	24.6
" 8% " ..	9 2	1 2	8 0	74	2 2	1.16	24.6
Cottonseed cake,							
English, Egyptian,							
seed, 4½% oil ..	5 17	0 19	4 18	42	2 4	1.25	17.3
Cottonseed cake,							
Egyptian, 4½% oil ..	5 7	0 19	4 8	42	2 1	1 12	17.3
Cottonseed cake,							
decorticated, 7-8% oil	7 12†	1 10	6 2	68	1 10	0.98	34.7
Cottonseed meal,							
decorticated, 7-8% oil	8 5†	1 10	6 15	70	1 11	1.03	36.8
Coconut cake, 5-6% oil	7 7	0 19	6 8	77	1 8	0.89	16.4
Ground nut cake, 6-7% oil	6 15*	1 0	5 15	57	2 0	1.07	27.3
Ground nut cake, decorticated, 6-7% oil ..	8 10*	1 10	7 0	73	1 11	1.03	41.3
Ground nut cake, imported, decorticated, 6-7% oil ..	7 5	1 10	5 15	73	1 7	0.85	41.3
Palm-kernel cake, 5½% oil	7 2†	0 13	6 9	73	1 9	0.94	16.9
Palm-kernel cake, meal,							
5½% oil ..	7 5†	0 13	6 12	73	1 10	0.98	16.9
Palm-kernel meal, 1-2% oil ..	6 15	0 13	6 2	71	1 9	0.94	16.5
Feeding treacle ..	5 0	0 9	4 11	51	1 9	0.94	2.7
Brewers' grains, dried ale	5 10	0 12	4 18	48	2 0	1.07	12.5
Brewers' grains, dried porter ..	5 2	0 12	4 10	48	1 10	0.98	12.5

* At Bristol.

§ At Hull.

† At Liverpool.

‡ In these instances manurial value, starch equivalent and protein equivalent are provisional.

NOTE.—The prices quoted above represent the average prices at which actual wholesale transactions have taken place in London, unless otherwise stated, and refer to the price ex-mill or store. The prices were current at the end of March, 1939, and are, as a rule, considerably lower than the prices at local country markets, the difference being due to carriage and dealers' commission. Buyers can, however, easily compare the relative values of the feeding stuffs on offer at their local market by the method of calculation used in these notes. Thus, if linseed cake is offered locally at £11 per ton, then since its manurial value is £1 2s. per ton as shown above, the cost of food value per ton is £9 18s. Dividing this figure by 74, the starch equivalent of linseed cake as given in the table, the cost per unit of starch equivalent is 2s. 8d. Dividing this again by 22.4, the number of pounds of starch equivalent in one unit, the cost per lb. of starch equivalent is 1.43d. Similar calculations will show the relative cost per lb. of starch equivalent of other feeding stuffs on the same local market. From the results of such calculations a buyer can determine which feeding stuff gives him the best value at the prices quoted on his own markets. The figures given in the table under the heading "manurial value per ton" are calculated on the basis of the following unit prices:—N., 7s. 9d.; P₂O₅, 2s 6d.; K₂O, 3s. 8d.

FARM VALUES OF FEEDING STUFFS

The prices in respect of the feeding stuffs used as bases of comparison for the purpose of this month's calculations are as follows :—

	<i>Starch equivalent Per cent.</i>	<i>Protein equivalent Per cent.</i>	<i>Per ton £ s.</i>
Barley (imported)	71	6·2	5 17
Maize	78	7·6	6 8
Decorticated ground-nut cake	73	41·3	7 17
„ cotton-seed cake	68	34·7	7 12

(Add 10s. per ton, in each instance, for carriage.)

The Table below is issued as a guide to farmers respecting the feeding value of their crops in relation to current market prices. (The " food values," which it is recommended should be applied by Agricultural Organizers and other advisers in connexion with advisory schemes on the rationing of dairy cows, are given in the December, 1938, issue of the Ministry's Journal, p. 965.)

FARM VALUES

Crop	<i>Starch equivalent Per cent</i>	<i>Protein equivalent Per cent</i>	<i>Food value per ton, on farm £ s.</i>
Wheat	72	9·6	6 11
Oats	60	7·6	5 9
Barley	71	6·2	6 6
Potatoes	18	0·8	1 11
Swedes	7	0·7	0 12
Mangolds	7	0·4	0 12
Beans	66	19·7	6 14
Good meadow hay	37	4·6	3 7
Good oat straw	20	0·9	1 14
Good clover hay	38	7·0	3 12
Vetch and oat silage	13	1·6	1 4
Barley straw	23	0·7	1 19
Wheat straw	13	0·1	1 2
Bean straw	23	1·7	2 0

WIRELESS TALKS, MAY, 1939

<i>Station and Date</i>	<i>Time p.m.</i>	<i>Speaker</i>	<i>Subject</i>
NATIONAL :			
4	6.20	Messrs. W. S. Mansfield and F. Day	Sterility in Mares.
11	6.20	Mr. J. F. H. Thomas	Farming To-day.
18	6.20	Do.	Do.
25	6.20	Mr. W. S. Mansfield and Dr. S. J. Watson	Silage.

WIRELESS TALKS

MIDLAND :			
1	6.30	Mr. S. Barron	Diseases in Cattle : Mastitis, Tuberculosis.
WALES :			
12	6.20	Messrs. E. L. Harry, J. Ellis and L. Evans	Marketing Methods : Past and Present
WEST :			
3	7.40	Professor R. Boutflour and West Country Farmers	Federation of West Country Farmers' Debate
11	6.40	Mr. A. W. Ling and a Butcher	The Butcher's Point of View
25	6.40	Messrs. A. W. Ling and H. T. Watkins	Soil Analysis and its Practical Value to the Farm.

AGRICULTURAL INDEX NUMBER

MONTHLY INDEX NUMBERS OF PRICES OF AGRICULTURAL PRODUCE
(BASE, 1927-29=100.)

Uncorrected for
Seasonal Variation

*Corrected for
Seasonal Variation*

Month	1937	1938	1939	1937	1938	1939
January	90	97	90	85	90	84
February	91	95	88	86	89	82
March	90	88	85	90	88	85
April	89	85		92	89	
May	82	82		88	90	
June	81	81		89	90	
July	82	86		88	94	
August	83	81		87	86	
September	87	81		89	83	
October	93	86		89	82	
November	99	89		92	82	
December	100	90		92	82	

THE SAME, TAKING ACCOUNT OF PAYMENTS UNDER THE WHEAT ACT (a),
THE CATTLE SUBSIDY (b), AND GOVERNMENT PAYMENTS FOR MILK (c).

Month	1937	1938	1939	1937	1938	1939
January	92	99	95*	86	93	89*
February	93	97	93*	88	92	88*
March	92	91	90*	92	91	90*
April	90	88		93	92	
May	83	84		90	92	
June	82	83		89	92	
July	83	88		89	96	
August	85	84*		89	89*	
September	89	84*		91	86*	
October	95	91*		91	86*	
November	101	94*		94	86*	
December	102	94*		94	86*	

(a) Commenced August, 1932. (b) Commenced September, 1934.

(c) Commenced April, 1934. * Provisional

FARM WORKERS' MINIMUM RATES OF WAGES

Agricultural Wages Board.—At meetings held on March 21, and April 4, 1939, Orders were made increasing the minimum rates of wages in Kent (from 34s. to 35s.) and Lancashire (Southern Area, 35s. 6d. unchanged), (Remainder of Area, from 39s. 6d. per week of 60 hours to 40s. 6d. per week of 58 hours); in the following areas the minimum rates were unchanged: Cornwall and Scilly (34s. 6d.), Derby (38s.), Hertford (35s.), Leicestershire and Rutland (Leicestershire 35s., Rutland 33s. 6d.), Lincolnshire (Holland) (37s. 6d.), Norfolk (34s. 6d.), Somerset (36s.), Suffolk (34s.), Sussex (34s. 3d.), Wiltshire (34s. 6d.), Denbighshire and Flintshire (32s.), and forestry workers (37s.), and Radnorshire and Breconshire (33s.) (The figures quoted are the minimum weekly wages for adult ordinary male workers except where otherwise stated.) The Orders also made directions with regard to holidays with pay, the number of days to be allowed as holidays for whole-time workers in regular employment being, in Cornwall and Scilly, 2 days; in Derbyshire, Kent, Somersetshire and Wiltshire, 3 days; in Leicestershire and Rutlandshire and Lincolnshire (Holland), 4 days; in Hertfordshire, 4 days where workers normally work 7 days per week, and 3 days in other cases; in Norfolk and Suffolk, 4 days in the case of special class workers (increased in Norfolk from 3) and 3 days in other cases; in Sussex, special class workers 6 days, and other workers 5 days; in Lancashire, 7 days for workers normally employed 7 days per week and 6 days for other workers; in Denbighshire and Flintshire, 7 days for special class workers and 6 days for other workers and forestry workers, and in Radnorshire and Breconshire, 3 days in respect of 6 months of employment. In all instances, holiday remuneration is fixed at daily rates proportionate to the minimum rates. For full details of the minimum rates and holiday directions, and of the various provisions connected with them, reference should be made to the Orders, copies of which may be obtained free of charge from the Secretary, Ministry of Agriculture and Fisheries, King's Buildings, South Square, London, S.W.1.

Enforcement of Minimum Rates of Wages.—During the month ending April 12, 1939, legal proceedings were taken against 8 employers for failure to pay the minimum rates of wages fixed by the Orders of the Agricultural Wages Board. Particulars of the cases follow:—

Committee Area	Court.	Fines Imposed	Costs Allowed	Arrears of Wages Ordered	No. of workers involved
Cardigan ..	Cardigan ..	£ s. d. 3 0 0	£ s. d. 4 13 6	£ s. d. 4 5 6	1
Cumberland ..	Wigton ..	1 0 0	2 4 0	10 0 0	2*
" ..	" ..	1 0 0	2 16 0	7 6 10	1
Lancashire ..	Haslingden	" A "	0 10 0	23 0 0	1
Shropshire ..	Bridgnorth	0 15 0	1 1 0	16 16 7	2
Stafford ..	Utttoxeter ..	" A "	0 10 6	16 0 0	1
Suffolk ..	Lowestoft ..	0 10 0	—	4 8 3	1
" ..	Halesworth	4 0 0	0 4 0	12 12 11	1
	Totals ..	10 5 0	11 19 0	94 10 1	10

* A " Dismissed under the " Probation of Offenders Act."

* Case of 1 worker withdrawn.

NOTICES OF BOOKS

The Science and Practice of Conservation : Grass and Forage Crops.

By S. J. Watson, D.Sc., F.I.C., with a foreword by Professor J. A. S. Watson, M.C., M.A., B.Sc., on behalf of the Agricultural Research Council's Committee on the Preservation of Grass and Other Fodder Crops. Volume I., Pp. xii + 416. Illus. (London : The Fertiliser and Feeding Stuffs Journal. Not dated. Price 30s.) (Two volumes.)

Dr. Watson surveys the vast amount of information dealing with the conservation of farm crops which lies scattered throughout the literature of the world. The general policy has been to use the work which the author has carried out at Jealott's Hill as a nucleus for each chapter, and round it to write a critical review of all the available information.

In the first volume, just issued, Dr Watson considers in detail the principles underlying haymaking, artificial drying, and all the processes of ensilage. It contains a wealth of data, all of which have been selected most carefully, and, in consequence, make the book an invaluable source of reference for all those questions which arise in connection with conservation. In addition to details of the processes themselves, the first volume deals with the losses involved and with the different materials found on the farm which can be conserved.

The book is not restricted in any way to the scientific side of the question, the important practical aspect being dealt with fully throughout.

Cattle Fodder and Human Nutrition. By Artturi I. Virtanen Pp 108 (Cambridge University Press. 1938. Price 7s. 6d.)

This book is based on four lectures at the Universities of London and Reading. The first two lectures discuss the mechanism of biological nitrogen-fixation and the symbiosis of the leguminous plants and legume bacteria respectively, while the third, on the production of vitamins in agriculture, with special reference to human nutrition, is in effect a report of the results obtained by an investigation, under the author's supervision, into the standard of nutrition of the Finnish working classes. The need for increasing the vitamin A potency of milk and milk products by methods of cattle feeding is emphasized. The fourth lecture deals with a method advanced by the author for the preservation of fresh fodder and its importance in agriculture. The book provides an interesting discussion, and the author may be congratulated on presenting so readable an account of a highly technical subject. The large number of references quoted will assist those who wish to pursue the subjects further.

Economics of Agriculture. By A. P. Van der Post, B.A. Hons (Cape), B.Sc.Agric.(Cornell). Pp. xxvii + 663. Tables and Figures. (South Africa : Central News Agency, 1937. London : Gordon & Gotch, Ltd. Price 25s.)

This is an exposition of the economics of agriculture written by a South African primarily for readers in the Union. The book covers a very wide field, and it will be stimulating to English readers by presenting economic problems connected with agriculture from a new angle. It will be agreed that Mr. Van der Post has produced a thoroughly readable and interesting volume

NOTICES OF BOOKS

The Structure and Composition of Foods. Vol. IV. By A. L. and K. B. Winton, Ph.D. Pp. xxxiii + 580. (London: Chapman & Hall, Ltd. 1939. Price 45s.)

With this volume the authors conclude their monumental work, of which three volumes have already appeared, on the Structure and Composition of Foods. The present volume deals with sugar, syrup, honey, tea, coffee, cocoa, spices, extracts, yeast and baking powder. While a detailed description can hardly be attempted here, it must suffice to say that the book has been arranged conveniently, and the treatment is exhaustive. As a work of reference the four volumes of this work will be invaluable. The book is admirably printed and well illustrated.

Weed Plates, with Explanations. By Prof. Dr. E. Korsmo. Series III. Plates lxi-xc, 1938. Leipzig C.I.: Koehler & Volckmar A.-G. & Co. Prices: Paper sheet form unmounted, 22 RM. per set; on leather paper with cloth edge and eyelets for hanging, 38 RM. per set; mounted on cards, 49 RM.; each with descriptive text-book in English, French, German or Norwegian, as desired.

Series I and II of this excellent work were noticed in the December, 1937, issue of this JOURNAL. The high standard of production and the careful preparation commented upon then have been fully maintained. These generously proportioned plates (33 × 25 in.) show various weed plants in their natural sizes and colourings, their seeds, flower sections, etc., and the accompanying booklet gives a general account of the botany and distribution of each weed. It is fitting that Dr. Korsmo's work on weed control should be so impressively illustrated, for, as the earlier reviewer wrote, it "must be regarded as second to none."

Up from Poverty. By D. Spencer Hatch. Pp. xviii + 208. Illus. (London: Oxford University Press. 1938. Price 4s. 6d.)

It is encouraging that this little book which deals with the problems of the rural population in India has quickly reached a fourth edition. The problem with which this book is concerned, is, as its title suggests, the raising of the standard of living of the millions of India's villagers, and it is discussed in short interesting chapters by a writer who is intimately acquainted with his subject. The difficulties of organizing a very simple form of rural education, and the vast opportunities for improvement which would derive therefrom; the place of co-operation in Indian rural life, and the problem of leadership are debated with sympathy and understanding. Lord Willingdon, in a foreword, says that, although progress is being made, the main obstacle to advance and progress lies in the psychology of the rural worker himself, owing to custom and habit of caste and tradition. It is hoped that Dr. Spencer Hatch's book may assist in a small way by indicating new methods of advance, and in the meantime, it provides a very interesting introduction to one of the problems of Indian rural life and administration.

Soil Analysis : A Handbook of Physical and Chemical Methods. Second Edition by C. M. Wright, M.A., F.I.C. Pp. x + 276 and 10 figs. (London: Thomas Murby & Co. 1939. Price 12s. 6d.)

In this, the second edition, the whole text has been revised; out-of-date and unimportant methods omitted; and several sections enlarged or re-written.

This excellent laboratory manual gives the working details of the recognized chemical and physical methods in use in the principal British and American laboratories, and includes the recommendation of the International Society of Soil Science.

NOTICES OF BOOKS

Agricultural Progress. Vol. XVI., Part I, February, 1939. (Wilding & Son, Shrewsbury.)

The current issue contains many interesting and instructive articles. Sir Daniel Hall and Mr. R. M. Wilson describe the early days and later development of the South-Eastern Agricultural College at Wye, whilst the teaching of agriculture in schools, county instruction in farm machinery, and the educational value of tours for agricultural students, receive special attention.

Two particularly important topics are very fully dealt with. Mastitis is discussed from the points of view of the veterinary surgeon, the cheesemaker and the bacteriologist. Methods of field laboratory diagnosis are explained. The other subject is afforestation, and Mr. A. W. Oldershaw backs up his protest against the afforestation of farm land with numerous examples of the way in which the Forestry Commission has operated in Suffolk. Mr. W. L. Taylor, a Forestry Commissioner, puts forward the other side of the case.

Other valuable articles deal with such things as the foot-rot diseases in cereals, manganese deficiency in relation to soils and crops, and the separation and analysis of soil clay fractions. A considerable space is devoted to book reviews.

The Cambridge Region. Edited by H. C. Darby. Pp. xii + 234. Maps and Diagrams. (Cambridge: University Press, 1938. Price 6s net.)

Prepared originally for the Cambridge meeting of the British Association in 1938, this book presents a scientific survey of the district round Cambridge. The chapters on soils, climate, botany, zoology, agriculture, archaeology, history, on the growth of Cambridge and other problems are an example of what can be accomplished by the collaboration of men of science in dealing with a particular area. Dr. McG. Carslaw and Mr. McMillan present a very competent survey of the agriculture of Cambridge which will probably be of greatest appeal to agricultural readers, but the interest of the book is well maintained throughout.

Birds Through the Year. By "Fish-Hawk" (David K. Wolfe Murray) Pp. 96. Illus. (London: Duckworth, 1938. Price 10s. 6d.)

As its title implies, this book is in a sense a bird calendar, although it is very much more than a record of birds seen or heard in the different months. It contains a good deal of useful information on the various species, with many personal opinions on matters of controversy. There is no doubt that "Fish-Hawk" is a keen and competent observer. His drawings are good, though some of them are a little stiff. The best are Peewit alighting, Dotterel, Common Snipe and Kittiwake.

"Fish-Hawk's" remarks on bird sanctuaries are pertinent and well timed, and are to be commended to the notice of the "whole-hog" type of bird protectionist. "Fish-Hawk" says:—

"Some of them become mere forcing houses for useless or harmful species, none of which are in danger of extinction or ever will be."

As to the Cuckoo, "Fish-Hawk" says:—

"Whenever possible I have always removed Cuckoos' eggs from nests and put an end to the young parasite to save the legitimate occupants. A nest full of young Hedge-sparrows will do far more useful work as insect killers than one Cuckoo."

The statement embodied in the latter paragraph is, to the say the least of it, debatable.

"Fish-Hawk" has been very well treated by his publishers and the book itself can confidently be recommended to bird lovers.

NOTICES OF BOOKS

Introduction to the Botany of Field Crops. By J. M. Hector.
Pp. xxxiii + 1127. Illus. (Johannesburg: Central News Agency.
1938. 2 vols. Price £3 10s.)

Since the turn of the century botanists have more and more tended to use as the material of their study plants of economic importance, and thus it comes about that detailed botanical knowledge of certain crop plants, for example wheat, beet and potato, to name some within the range of British agriculture, exceeds in volume that of any other species or genus. In the present volumes Professor Hector collects and systematizes what is known of "field crops," in which category he includes plants cultivated as arable crops and excludes those of garden, orchard and plantation. It is a text-book for the advanced student in botany and should occupy a place on the laboratory shelves for the post-graduate student and researcher.

Volume I is occupied by the Cereals, Volume II by the Non-Cereals. Author, plant and general indexes are provided. It is a monumental work and the publishers are to be congratulated on their part for producing two volumes of such quality as regards paper, printing and illustration.

Common British Grasses and Legumes. By J. O. Thomas and L. J. Davies. Pp. vii + 124. Illus. (London: Longmans Green & Co. 1938. Price 6s.)

This should prove a useful book for students. It contains a description of the common grasses and legumes, and includes upwards of 50 illustrations as a guide to the identification of the different species. For teaching purposes and as a book of reference this book should be of definite value.

Proceedings of the International Conference of Agricultural Economists—Fifth Conference, 1938. Pp. xiv + 436. (London: Oxford University Press, 1939. Price 17s 6d.)

The Fifth International Conference of Agricultural Economists met in Canada in August last year under the Presidency of R. L. K. Elmhirst. This handsome volume contains the papers read at the Conference and reports the discussions, the views of over fifty well-known agricultural economists from all over the world focussed on certain main subjects which are fundamental to the economic and social welfare of the world.

For instance, Dr. H. A. Wallace, Secretary of Agriculture in President Roosevelt's Administration, speaks on "International Trade in Relation to Agricultural Development" and replies to criticisms of American policy made by other speakers at the Conference.

The Chief of the Agricultural Section of the I.L.O., Dr. F. von Bulow, and the President of the International Landworkers Federation, Mr. J. F. Duncan, speaks on "Farm Labour and Social Standards."

Dr. Henry C. Taylor, Director of the Farm Foundation, Chicago, and formerly U.S. permanent delegate to the International Institute of Agriculture, Rome, and Professor C. von Dietze, University of Freiburg, Germany, speak on the "Social Control of the Use of Land."

The Chief of the Economics Branch of the Canadian Department of Agriculture, Dr. J. F. Booth, and the Under-Secretary for Agriculture in the Roosevelt Administration, Mr. M. L. Wilson, speak on "The Social Implications of Economic Progress in Agriculture."

Among other papers are the following: "Recent Changes in New Zealand's Economic Policy," by the Director of Agriculture for New Zealand, Mr. A. H. Cockayne. "An Outline of the Economic Structure of Agriculture in Argentina," by the U.S. Agricultural Attache in Buenos Ayres, Dr. P. O. Nyhus. "The Mexican Agrarian Reform," by Dr.

NOTICES OF BOOKS

Ramon Fernandez. "Recent Agricultural Experience in Eire," by Senator J. Johnston, Fellow of Trinity College, Dublin. "Agricultural Co-operation in Canada," by Mr. A. E. Richards, Canada. "National and Local Taxation in Rural Areas," by Professor B. H. Hibbard, U.S.A.

This book, which is very well produced, reports the Conference in a worthy manner.

Avian Tuberculosis Infections. By William H. Feldman, D.V.M., M.S.

Pp. ix + 483. Illus. (London: Baillière, Tindall & Cox, 1938. Price 31s. 6d.)

This admirable monograph is composed of thirteen well-balanced chapters, illustrated and a list of references appended to each chapter.

The earlier chapters give an account of the history of our knowledge of avian tuberculosis and the relation of age of the birds to incidence of infection. The biologic characteristics, and isolation and cultural techniques are very fully dealt with.

Chapters are devoted to the pathogenicity of the avian tubercle bacilli for birds other than fowls, for cattle and swine, human beings and certain other mammals. It is recorded that tuberculosis among wild birds is rare and probably results in all instances from exposure to infective material derived from the domestic fowl.

The chapters dealing with the pathogenicity of the avian tubercle bacilli for swine and cattle are lengthy and supply interesting information.

The author states "It is commonly believed that tuberculosis of swine caused by the avian tubercle bacillus is essentially a non-progressive localised disease of the lymph nodes and that widely disseminated or generalized lesions are of infrequent occurrence. However, generalization probably occurs much more frequently as a consequence of infection with the avian tubercle bacillus than is usually recognized.

"The data seem to indicate that avian tubercle bacilli in swine have a tendency to escape from the lesions and enter the bloodstream, by which they may be distributed widely over the body."

Feldman sums up the position regarding the danger of avian tubercle bacilli to cattle as follows: "From the information available it appears that, under ordinary conditions of natural exposure, avian tubercle bacilli have but limited pathogenicity for cattle. Although sensitization to avian tuberculin may be expected to develop in a large percentage of bovines following exposure in an infected environment, such sensitivity is transitory and dependent upon continuation of the exposure. Exceptionally, cattle exposed to the avian type of tuberculosis infection will react to mammalian tuberculin. Demonstrable lesions may or may not develop as a consequence of exposure to avian tubercle bacilli and when lesions occur, the disease is characterized by its localized, benign, or regressive nature."

This monograph will prove of inestimable value to all interested in the problems of avian tuberculosis infections.

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Photo.

HEREFORD BULLOCKS.

[F. C. Nicholas.

including the Champion Bullock at Stafford Smithfield Fat Stock Show, 1938, which weighed 12½ cwt., and was sold for £32. Four of these Beasts took First Prize at the same Show, and four others, also shown in this photograph, First Prize at Eddeshall Fat Stock Show, 1938. The property of our esteemed customer, A. Malpass, Esq., Lower Cowley Farm, Gnosall, Staffs. Fed on Bibby's High Carbohydrate "Cakelettes".

The Ideal Cake for Summer Feeding...

It has been proved without any shadow of doubt that the only Cake which makes the most of young succulent grass is one of a high carbohydrate content, to remedy the deficiency of carbohydrates in the pasture grass, and low in protein to balance the richness of young grass in this respect, and thus prevent scouring.

Such a food is Bibby's High Carbohydrate Cake which, apart from satisfying these requirements, offers the additional advantage of a particularly high feeding value due to an unusually low fibre content. Bibby's High Carbohydrate Cake is equally suitable for milk production and fattening, and those who adopt it during the coming Spring and Summer months will find the results considerably to their advantage.

BIBBY'S HIGH CARBOHYDRATE "CAKETTES"

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THE JOURNAL OF THE MINISTRY OF AGRICULTURE

VOL. XLVI

No. 3

JUNE 1939

AGRICULTURAL POLICY

During the past month, the Minister of Agriculture has made several statements in the House of Commons in connexion with agricultural policy. These have dealt with grants in respect of the ploughing-up of permanent grass land, price insurance for sheep, barley and oats, and emergency reserves of tractors and agricultural machinery. Details of the statements are printed below.

In connexion with the ploughing-up of permanent grass land, the attention of readers is drawn to the article on pp. 290-295 of this issue, in which various technical points regarding the ploughing-up of grass on different types of soil are dealt with, together with recommendations for cropping, manuring and re-seeding.

Payments for Ploughing-up Grass Land. In reply to a question on May 3, the Minister of Agriculture made the following statement:—

“ Under the Government’s general plans for ensuring food supplies in time of war the function allotted to the Agricultural Departments is that of making the arrangements that would be required in the event of an outbreak of war to bring about an expansion of food production in the United Kingdom.

Plans have accordingly been prepared for a central and local organization which would be responsible for giving effect to arrangements for increasing the production of food and feeding stuffs. The Agricultural Departments would be responsible for the central direction and Executive Committees would be set up in each county to whom important functions would be delegated. The names of the gentlemen whose services the Government has been able to secure as Chairmen-designate of these prospective

Committees in England and Wales and in Scotland are being circulated in the Official Report.*

An expansion of home food production would necessarily involve an increase in the arable area obtained by means of a ploughing-up campaign. The particular crops, the production of which we should have to expand, would depend on a number of circumstances, including the season of the year when an outbreak of war occurred, the situation in regard to food reserves in this country and overseas supplies, and the suitability of the newly ploughed land for particular crops, whether for human consumption or for feeding stuffs for our live stock which provide vital supplies of milk and meat.

A great deal of information has been collected by the Agricultural Departments and prepared in a form in which it would be immediately available for the proposed Executive Committees.

A reserve of fertilizers has been secured, and plans have been made to organize and control the supply and distribution of fertilizers, feeding stuffs, tractors and other machinery, fuel, implements, seeds and other farm requisites for the industry's war-time requirements.

The problem of labour has been carefully considered with the other Departments concerned. In addition to the safeguards provided under the scheme of reserved occupations, steps are being taken to enrol persons willing to undertake work on the land in time of war, and plans are being made for training by intensive courses, in the event of a war, those who have had little or no previous agricultural experience. This matter is now receiving further consideration in the light of recent Government decisions in regard to the Territorial Army and compulsory military service.

The Government do not consider it necessary or desirable that the plans for production on the scale or of the character that would be required in time of war should be put into operation in advance of an outbreak of war. They consider that the best preparation for an emergency is to bring the land into a state of greater fertility which would enable it to respond more fully to the increased demands which would be made on it in the event of an outbreak of war. The Government therefore desire that farmers should make a special effort this summer to improve

* Not reproduced in this JOURNAL.

their poorer grass land, large areas of which could not in its present condition yield satisfactory crops.

To assist farmers to improve the potential productivity of such land the Government propose to ask Parliament to authorize the payment of contributions of £2 per acre in respect of permanent grass ploughed up after this announcement and before September 30, 1939,* and brought into a state of cleanliness and fertility by re-seeding, or by fallowing or sowing to an approved crop with a view to re-seeding. The objective would be to encourage farmers to carry out work which in any case is desirable in order to convert poor or worn-out grass land into more productive pasture and would, if the need arises during the autumn or spring, enable the land to be readily used, as arable land, for raising such crops as might be required to supplement supplies of food or feeding stuffs.

The Government would urge farmers, in consultation where necessary with the landowners concerned, to make arrangements to plough up during the summer inferior permanent grass land that would benefit by re-seeding and could, if necessary, be put in a condition to produce suitable crops. Notice of intention to plough up must be given to Agricultural Departments in England and Wales, Scotland and Northern Ireland, in order that the land concerned may be inspected at the discretion of the Departments, either before or after ploughing. Applicants will be required to satisfy the Departments that the land has been down to grass for not less than seven years. No payment will be made in respect of areas of less than two acres, and fractions of less than half an acre will be disregarded.

Further details and particulars of the form in which notice of intention to plough up should be given will be issued at an early date.

The necessary legislation will be introduced as soon as possible, and it is contemplated that payment of the Government contributions would be made in the autumn, subject to the Departments being satisfied that the work has been duly carried out and that any necessary safeguards or conditions have been observed.

The Government are confident that they will have the

* The extension of this date to October 31, 1939, was announced in a statement made by the Secretary of State for Scotland on May 16.

fullest support and co-operation of the agricultural community in this effort to improve the productive capacity of our soil."

Price Insurance for Sheep, Barley and Oats. The following statement was made by the Minister in the House of Commons on Thursday, May 18, 1939:—

" The general review of the agricultural situation which was initiated earlier in the year, and the subsequent discussions with representatives of the farming industry and of other interests, have now reached the stage when the Government are in a position to announce the conclusions at which they have arrived in regard to the application of the principle of price-insurance to sheep, barley and oats.

SHEEP. Sheep form an essential feature of the agricultural economy of a large part of the country and past experience suggests the desirability of safeguarding the industry against serious losses, such as occurred in 1938. The Government accordingly propose to invite the Livestock Commission to prepare a scheme of price insurance which would provide a deficiency payment from the Exchequer on sheep (excluding ewes and rams) which are presented for sale for slaughter and exceed a prescribed qualifying minimum weight. It is proposed that these deficiency payments should be made in respect of standard weights; that is to say, a given amount per head would be paid in respect of all sheep of the same class eligible for subsidy, irrespective of their actual weights. There would, however, be two different classes of sheep with different qualifying and standard weights, consisting of a lighter class and a heavier class.

It is proposed that the monthly standard prices for sheep should follow the normal seasonal variations and should be such as will average 10*d.* per lb. over the year and that this figure should be related to a total United Kingdom sheep population of 27 millions, subject to provision being made for varying the standard price in the event of the sheep population rising above this figure or of the standard price being in excess of the market price for two years in succession. To give effect to this provision it is proposed that:—

- (1) The standard price should be " stepped down " by $\frac{1}{8}$ *d.* in relation to successive increases of 250,000 in the total United Kingdom sheep popu-

lation above 27 millions up to a figure of 28 million and by $\frac{1}{4}d.$ for each successive 250,000 thereafter; and

- (2) If the standard price should be for two successive years in excess of the market price, the standard price of $10d.$ as related to the basic sheep population of 27 millions would be scaled down, subject to a review in which all relevant factors, including imports, would be considered.

OATS. On February 23, I announced that the Government had reached the conclusion that the provisions of the Agriculture Act, 1937, in respect of oats and barley were inadequate and that additional assistance was required by growers of these cereals. The purposes for which these crops are grown are very different and it is accordingly considered that they merit separate treatment in future. Under the Agriculture Act, 1937, growers of oats who receive wheat-deficiency payments are debarred from receiving oats subsidy. It is proposed that these growers should be entitled to receive oats subsidy based on 6 cwt. per acre with a maximum payment of £1 per acre. Growers of oats who do not receive wheat-deficiency payments are entitled at present to receive oats subsidy based on 6 cwt. per acre. It is proposed that these growers should be entitled to receive oats subsidy based on 14 cwt. per acre, with a maximum payment of £2 6s. 8d. per acre. The standard price will be, as at present, 8s. per cwt., and deficiency payments will be calculated according to the difference between the average market price of oats in the United Kingdom during the seven months September-March, and this standard price. The average market price in the United Kingdom will be determined by weighting the average prices in England and Wales, Scotland and Northern Ireland, respectively, according to the acreages in each country qualifying for the higher rate of subsidy.

It is proposed that the maximum acreage in respect of which the full rate of subsidy will be applied should be 2,500,000 acres, which will be divided as to 1,030,000 acres in respect of growers who take wheat-deficiency payments and 1,470,000 acres for non-wheat growers.

It is proposed that this additional assistance should be applied retrospectively to the 1938 crop, any payments

received under the Agriculture Act, 1937, being treated as advances. The effect of these proposals in respect of the 1938 crop will be that oat growers who receive wheat-deficiency payments will, if Parliament approves, now receive a payment of 13s. 6d. per acre. Oat growers who grew no wheat or who chose not to receive wheat-deficiency payments, will receive a payment of 18s. 4d. per acre in addition to the payment of 13s. 2d. which they have already received under the Agriculture Act, 1937. Those farmers who did not apply for oats subsidy during the prescribed period last year will be given a further opportunity of applying.

BARLEY. The production of barley in the United Kingdom is designed in the main to meet the requirements of brewers, distillers and other users of barley for malting purposes, and these industries have expressed their willingness to co-operate in ensuring to the grower a reasonable price for that part of his crop, the continued production of which it is in their interest to maintain. It is proposed that the risks attaching to the remainder should be insured by the Exchequer. Substantial progress has been made in the discussions with the malt-using industries, which are still proceeding, and I have every hope that a satisfactory scheme will be evolved at an early date. It is proposed that the rate of Exchequer assistance should be related to a "ceiling" of 18 million cwt., which is, on the basis of average yields, the produce of 1,250,000 acres, after making an allowance of 10 per cent. for seed and waste.

It is clear, however, that no plan of the kind under discussion with the malt-using industries could be applied retrospectively, and it is accordingly proposed that, in respect of the 1938 crop, growers of barley shall receive assistance at the same rates and on the same terms as are proposed for growers of oats.

The effect of this proposal in respect of the 1938 crop will be that barley growers who received wheat-deficiency payments will, if Parliament approves, now receive a payment of 13s. 6d. per acre. Barley growers who grew no wheat or who chose not to receive wheat-deficiency payments will receive a payment of 20s. 8d. per acre, in addition to the payment of 10s. 10d. per acre which they have already received under the Agriculture Act, 1937. As in the case of growers of oats, a further opportunity of applying for

subsidy will be given to those farmers who did not make application within the prescribed period.

Provision will be made for varying the standard prices referred to in this statement if there is a material change in conditions. For this purpose it is proposed that Ministers should be given power, with the approval of the Treasury, and subject to the affirmative resolution procedure in Parliament, to vary the standard prices by statutory order.

The legislation necessary to give effect to these proposals will be introduced as soon as possible."

Emergency Reserves of Tractors and Agricultural Machinery. Introducing a Supplementary Estimate on May 17, to provide for the creation of a reserve of tractors and other agricultural machinery, the Minister stated that it covered an important item in the Government's preparations for increasing the home production of food in the event of war. He emphasized that the reserve of tractors which it is proposed to create is intended to facilitate a ploughing-up campaign in an emergency. The tractors will not be available for farmers who wish to qualify for the £2 an acre subsidy scheme announced on May 3; the Government expects farmers to make their own arrangements for acquiring any additional machinery they may need to make the best possible use of that scheme.

The reserves will, as far as possible, be obtained from home sources. It is intended that the tractors shall be held by dealers on behalf of the Government in addition to their ordinary stocks, and that the Government stock shall be turned over regularly in the course of trade. There will thus be no risk of depreciation and no disturbance of the market. The sole purpose of the scheme is to ensure that, in the event of war, the Government shall have at its disposal a supply of tractors for immediate use in those parts of the country where the existing supply would be deficient.

The Government proposes to make arrangements for establishing a similar reserve of other agricultural machinery.

AIDS TO FARM MANAGEMENT

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Nothing is more difficult, possibly, in farm management than to determine the causes of success or failure. Particularly is this true of the general run of farms and farmers, for the exceptional cases can be assigned to genius. Men like Samuel Farmer, who accumulated 25,000 acres of land in his own management and a fortune of nearly half-a-million pounds, and George Baylis, who laid the foundations of a business and of a fortune of just half that size by corn-growing during the agricultural depression of last century, would have done equally well, no doubt, in any other walk of life. They had a genius or an instinct for management which never failed them, and when their ventures had attained to certain proportions their further increase was almost an arithmetical progression to which the limits were merely physical. Could they find more land to add to that which they had already, within working distance? Would the day be long enough for the additional administration which the extra land would entail? These men and others like them were complete individualists. They owed nothing to scientific management as it is understood and practised in other forms of big business, with its elaborate planning, its system of financial control and its specialization of labour. When they died, the great organizations they had built up died with them.

But what can the general run of farmers do to test and to increase the efficiency of their farming systems, and what can the advisory services organized by the State do to help them in this? Farming for self-supply in a primitive community may be a matter mainly of maximum production: labour, manures, anything which is applied to increase the physical output of the land is well applied. But farming for the market in a modern industrial state is measured by a different standard: capital and labour are well applied only if the costs which they represent are more than recovered in the prices of the resultant products. This is the test, to-day, of any farming system and of every farm manager.

It has been said that farm management has its own fun-

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damental science, book-keeping, and this is true. Of course, the men of genius—Baylis, with his corn-growing rotation; Hosier, with his downland dairying; the Bomfords, with their mechanical ingenuity; Abbott, with his group of specialized industries organized to fit into the framework of one farm—these men and their like may have hit upon things which transcend all else in the influence which they exert upon the success of the business. But for the majority of men success is dependent, Martha-like, on being careful over many things, and the financial analysis of the system which accountancy and records make possible is the means to the exercise of that care. For that reason, the method of assessment to income-tax applied to farming may be a real hindrance to success. The rental basis of assessment of farmers' profits for taxation obviates the necessity imposed on all other producers of keeping books of account, and so there is no incentive to overcome the natural reluctance of the man whose work is conducted mainly in the open air, to organize an office and to busy himself with clerical duties. My own view is that the abolition of Income-tax, Schedule B, would be a blessing in disguise if it were to cause farmers to keep even the simplest financial records.

It is not suggested that much more than this can be required. The turnover of the average farm is too little to justify an office equipment and clerical assistance. On large or on intensively-farmed holdings this may be called for, and the determination of labour and product costs may repay the effort they require. Otherwise, a yearly inventory and a record of receipts and payments are what can be expected of every farmer, supplemented by as many other records—time-sheets for his men; records of food consumption by live stock; records of the application of fertilizers, etc.—as he can be induced to keep. He is then equipped with the means for making a statistical examination of his farm management, and some analysis of its financial results.

What, for example, is the distribution of his capital amongst the different branches of his business? What is the proportion of it invested in those directly productive, such as live stock, tillages, etc., and in those only indirectly productive, such as implements and machinery, tenants' fixtures, etc? What is the rate of his turnover and how does it vary in the different departments of the farm? How is his gross annual expenditure apportioned between rent, labour, feeding stuffs,

CHART I.—SHOWING HOW FARM No. 4 VARIED IN CERTAIN PARTICULARS FROM THE AVERAGE OF TWENTY-ONE MILK-SELLING FARMS IN SOUTH OXFORDSHIRE RANGING IN SIZE FROM 103 TO 205 ACRES

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
									Foods		Labour					
									Cost of Bought Foods per Acre	Grain Fed as per-centage of Total Grain Grown	Wages Paid per Acre	Value Family Labour per Acre	Rent per Acre	Misc. Bills per Acre	Total Out-goings per Acre	Margin between Direct Expenses and Cash Receipts per Acre
Size of Farm	Per-centage Arable	No. of Cows	Average Yield per Cow	Average Price per Gal.	Income per Acre from Milk	Income as per-centage of Total Income	Total Income per Acre									
Acres	%	No.	Gal.	s. d.	s.	%	£ s.	s.	%	%	s.	s.	s.	s.	£ s.	s.
Highest	205	88	36	— 768 —	1 3 —	133	78	63	100	9	52	47	42	25	12 6	109
	200	80	34	734	—	127	75	58	96	58	49	43	41	24	11 13	98
	195	73	33	700	—	120	72	54	92	54	46	40	40	23	11 1	86
	190	66	31	666	—	113	69	49	88	48	43	36	38	21	10 8	75
	186	59	30	632	—	106	66	44	84	44	41	32	37	20	9 16	64
	181	52	28	599	—	99	64	40	79	38	38	29	36	19	9 3	52
	176	44	27	565	—	93	61	35	75	35	35	25	35	18	8 11	41
	171	37	25	531	—	86	58	31	71	32	32	22	33	16	7 18	29
Average	166	30	24	497	1 2	79	55	26	67	67	29	18	32	15	7 6	18
	158	26	22	474	—	72	53	23	63	63	27	16	31	14	6 17	13
	150	22	21	451	—	66	50	20	58	58	24	14	29	13	6 9	8
	142	19	19	428	—	59	47	17	54	54	22	12	28	12	6 0	3
	134	15	18	404	1 1	53	45	14	50	50	20	10	27	11	5 12	2
	126	11	16	381	—	46	42	11	46	46	17	8	25	9	5 3	7
	119	7	15	358	—	39	40	8	37	37	15	7	24	8	4 15	12
	111	4	13	335	—	33	37	6	37	37	13	5	23	7	4 6	17
Lowest	103	—	12	312	1 0	26	34	3	30	30	11	3	22	6	3 18	22

Farm 4	177	18.6	20	768	1 3	94	50.4	9 6	5	84.4	18	31	36	6	5 7	109
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manures, implements and machinery, and tradesmens' bills? In what proportions do the different farm departments contribute to his gross annual income? What does his expenditure and his income under the various heads amount to per acre of the land he occupies? What is his total profit and his profit per acre, and what rate of interest does this represent on the capital invested?

The only demand which the record and account keeping needed for these purposes makes is upon the farmer's time. He need not be an accountant to undertake this work, and he will find a wide choice of account books designed to simplify it for him. A small number of farmers are already doing it, while others pay professional firms to do it for them. But the value of the work lies not in doing it but in the uses to which it is put, after it is done, and it is in the interpretation of his figures that the farmer may need assistance. It is here that the economic advisory service can help. It is not the business of the advisory economists to keep farmers' records for them, but with the information that they have about the economics of the different farming systems of their localities, they can contrast the performance of the individual with that of the group and can point out the directions in which his practice and his results diverge from it. Here, for example, is the analysis of a farmer's income and expenditure arranged to show him the ways in which it differed from the averages of a group of farmers similarly engaged and in the same locality.

This chart consists, in effect, of a series of clinical thermometers, which measure the reactions of the individual compared with the rest of the group. Take, for example, Column no. 1, "Size of Farm." The largest in the group was 205 acres, and the smallest 103 acres, while the average of them all was 166. A scale is constructed, of an equal number of readings above and below the average, on which is marked the place occupied by the farm under consideration. Farm No. 4, the example we have taken, is 177 acres, that is to say a little above the average size, and its place is marked on the scale by a thick black line between the figures 176 and 181. So for the rest of the chart, the position of this farm in each of the other measurements of farm activity is marked in the same way.

Certain things emerge. Taking the last column first, this farm has the highest margin between direct expenses and cash

CHART II.—SHOWING HOW FARM NO. 74 VARIED IN CERTAIN PARTICULARS FROM THE AVERAGE OF TWENTY-ONE MILK-SELLING FARMS IN SOUTH OXFORDSHIRE RANGING IN SIZE FROM 103 TO 205 ACRES

	1	2	3	4	5	6	7	8	9	Foods		10	11	12	13	14	15	16
	Size of Farm	Per-centage Arable	No of Milk Cows	Average Yield per Cow	Average Price per Gal.	Income per Acre from Milk	Income from Milk per Acre as per-centage of Total Income	Total Income per Acre	Cost of Foods per Acre	Grain Fed as per-centage of Total Grain Grown	Labour		Wages Paid per Acre	Value of Family Labour per Acre	Rent per Acre	Misc. Bills per Acre	Total Out-goings per Acre	Margin between Direct Expenses and Cash Receipts per Acre
	Acres	%	No.	Gal.	s. d.	s	%	£ s.	s.	%	s.	s.	s.	s.	s.	s.	£ s.	s.
Highest	205	88	36	768	1 3	133	78	12 8	63	100	47	42	52	43	41	25	12 6	109
	200	80	34	734	—	127	75	11 15	58	96	49	40	46	40	40	24	11 13	98
	195	73	33	700	—	120	72	11 2	54	92	40	40	43	36	38	23	11 1	86
	100—	66	31	666	—	113	69	10 9	49	88	43	36	41	32	37	21	10 8	75
	186	59	30	632	—	106	66	9 17	44	84	38	29	35	25	35	20	9 10	64
	181	52	28	599	—	99	64	9 4	40	79	38	29	35	25	35	19	9 3	52
	176	44	27	565	—	93	61	8 11	35	75	32	22	32	22	33	18	8 11	41
	171	37	25	531	—	86	58	7 18	31	71	29	18	29	18	32	16	7 18	29
Average	166	30	24	497	1 2	79	55	7 5	26	67	27	31	27	16	29	15	7 6	18
	158	26	22	474	—	72	53	6 15	23	63	24	29	22	14	31	14	6 17	13
	150	22	21	451	—	66	50	6 6	20	58	22	28	22	12	28	13	6 9	8
	142	19	19	428	—	59	47	5 16	17	54	20	27	20	10	27	12	6 0	3
	134	15	18	404	1 1	53	45	5 7	14	50	17	25	17	8	25	11	5 12	—
	126	11	16	381	—	46	42	4 17	11	46	15	24	15	7	24	8	4 15	—
	119	7	15	358	—	39	40	4 8	9	42	13	23	13	5	23	7	4 6	—
	111	4	13	335	—	33	37	3 18	6	37	11	22	11	3	22	6	3 18	—
Lowest	103	—	12	312	1 0	26	34	3 9	3	30	—	—	—	—	—	—	—	—

Farm 74	190	56.3	36	404	1 2	92	63.0	7 6	44	53	49	14	34	16	8 13	— 11
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receipts (Col. 16). This is not because its total income per acre is exceptional (Col. 8), or that it depends more than other farms upon dairying (Cols. 3, 6 and 7) or that its rent is exceptionally low (Col. 13). What strikes the eye is that the average milk yield per cow is the highest of any (Col. 4); that the milk realized the highest price (Col. 5); that very little was spent on purchased foods, while nearly all the home-grown grain was fed to the cows (Cols. 9 and 10); that a large part of the labour was family labour and cash wages were low (Cols. 11 and 12); and that miscellaneous tradesmen's bills were the lowest of any of the farms in the group.

Here, obviously, is a hard-working family farmer who has graded up his dairy herd to a high pitch and is getting the top price for his milk. He is growing crops for cow feed rather than for the market, with apparently excellent financial results, and he is looking twice at every sixpence before he buys anything. It would be difficult to offer any advice to this man on how to increase his efficiency. It is possible that some of the financial success is the result of undue economy on the general maintenance of the farm or its equipment, reflected in the small expenditure shown in Cols. 14 and 15, and that this will involve a day of reckoning sooner or later, but an inspection of the farm would settle this point.

Chart II shows the position of another farm, No. 74 in the same group of dairy holdings. Looking at its cash margin, it appears at once that it is on the wrong side, the farm being one of the worst in the group (Col. 16). In size it is roughly the same as farm no. 4 analysed above (Col. 1); the income from milk is about the same (Col. 6); the rent is very similar (Col. 13); milk sales are even a larger part of the total income (Col. 7); the total income per acre is fully up to the average of the group (Col. 8). We must look elsewhere for the explanation of the bad financial results.

In the first place, this farm has the largest number of cows, but one of the lowest average milk yields (Cols. 3 and 4). The farmer depends more upon bought than upon home-grown concentrates (Cols. 9 and 10), while his labour is almost entirely hired (Cols. 11 and 12). Further, his miscellaneous tradesmen's bills, though not much above the average, are a great deal higher than on farm no. 4.

The analysis suggests clearly enough that here is a farm on which, although milk-selling is the most important branch, the dairy herd calls for drastic improvement. The cost of

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COSTS OF HARVESTING BY COMBINE-HARVESTER

Farm Number	Proportion of Total Cost			Cost per Acre	Yield per Acre	Cost per Quarter
	Combining	Trucking	Drying and Dressing			
	Per cent.	Per cent.	Per cent.	£ s. d.	Bushels	£ s. d.
14	50	24	26	0 12 3	36	0 2 8
4	57	12	31	0 14 8	37	0 3 2
12	65	12	33	0 13 10	33	0 3 4
6	72	8	20	0 17 5	41	0 3 5
5	67	11	32	0 13 11	32	0 3 6
1	50	11	39	0 14 11	33	0 3 7
2	59	8	33	0 12 8	26	0 3 10
Average	57	13	30	0 16 3	30	0 4 5
13	66	6	28	0 12 8	23	0 4 6
3	53	16	31	1 0 0	32	0 5 0
10	63	10	27	0 17 4	27	0 5 2
9	45	21	33	0 13 3	20	0 5 3
15	55	17	28	1 1 9	32	0 6 1
7	55	10	35	1 0 9	25	0 6 8
8	57	13	30	1 0 3	23	0 6 11
11	53	10	37	1 2 11	24	0 7 2

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concentrated food is well above the average of the group, while the milk yield per cow is one of the lowest. The place of the farm on the chart in other particulars does not seem to call for comment, and unless the poor herd performance can be explained by an outbreak of contagious abortion or some other disaster, the farmer would be well advised to attempt to improve the average performance of his cows and perhaps to reconsider the construction of his food rations.

Financial analyses of individual farm management can be made in the same way for any other type of farming, and by collaboration between farmers and agricultural economists, an advisory service of real value could be built up by this means.*

This is the kind of help which the farmer may expect to get from simple financial accounts in tightening up the efficiency of his management. It must not be supposed that divergencies from the averages of other producers in his class point necessarily to weaknesses in his own organization. They should arrest his attention, however, and he should satisfy himself, for example, that if his feeding stuffs are costing him more, it is because his milk records are better, or that if his labour bill is higher, it is because his total farm sales are also above the average. In the absence of any such satisfactory explanations, he has a definite pointer to something in his management which he should reconsider.

But more than this can be done to stimulate efficiency, if records available have been compiled in greater detail. There are rare instances of farmers who supplement their financial records with cost accounts, while throughout the country as a whole, the advisory economics service is engaged in making cost of production surveys, either of products or of farming systems. With the aid of such cost of production studies, the process of tracking down and stopping leakages can be carried a stage further, for while a financial analysis may suggest that total labour costs, for example, are too high, a cost analysis may show where this loss of effective work is being incurred. Here is an analysis of the costs of harvesting by combine-harvester on 15 farms, tabulated in descending order of efficiency as indicated by the total cost per quarter.

It will be observed that about 57 per cent. of the total costs

* This method was devised by Professor H. C. M. Case, of Illinois, and the examples quoted are from a farm management survey made in South Oxfordshire by R. N. Dixey.

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are incurred on cutting and threshing, about 30 per cent. on drying and dressing and about 13 per cent. on trucking. Farm no. 6 stands about midway in the top half of the table, when assessed by the standard of total cost per quarter, but an examination of the analysis suggests that it may owe this place to its high crop yield per acre, the highest, in fact, of all the farms, rather than to any special efficiency in handling the harvest. The acreage costs are the highest of any farm in this half of the Table, as also is the proportion of total cost represented by cutting and threshing. Thus, the question for the farm manager here is: are these costs due to the exceptionally heavy crop which he had to handle, or to anything which can be improved on in his manner of handling it?

Or take farm no. 9, about the middle of the lower half of the Table. Here the acreage cost is almost the lowest of any, but so also is the yield, and the analysis of the total cost shows that trucking accounted for a higher proportion of the whole than on any of the farms except no. 14. Here the questions for the manager to consider are: can he do anything to increase the yield of his crop without incurring diminishing returns, and is there any reason—abnormal distances from the fields to the drier, for example—to account for the high cost of trucking?

To refer to another example, much use of costing, or of surveys of costs, has been made in the study of milk production. The great variations brought to light, not only in total gallon costs but in the items which go to make up those total costs, are well known through many publications. Collaboration between the milk-producer and the advisory service of his locality could supply the means, here also, for an examination of individual efficiency in milk production. Divergencies from a normal or from an average should arrest the attention of the farm manager and should lead him to consider whether they can be explained or whether they call for action on his part to reduce costs or to increase output.

The purpose of this article is to suggest that farm management is not entirely a question of the inherent business aptitude of the farmer. It is a science just as feeding live stock or manuring the soil are sciences, and it is susceptible to measurement and control just as they are. That this has not yet been fully realized is the explanation, probably, of a good many of the difficulties of farmers in these difficult days.

AGRICULTURAL CONTRACT WORK

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At the last Oxford Farming Conference, a good deal of interest was taken in a paper which Mr. Moses Griffith contributed on "Grassland Improvement by Contract"; the discussion outran the time allotted for it, and there were numerous inquiries on the subject afterwards. It was, in fact, evident not only that many farmers were keenly interested in contract work, but also that few of them realized what extensive facilities exist for getting such work done. Some of the work described by Mr. Griffith was of a very special kind—ploughing steep boulder-strewn hillsides which had, in all probability, never been cultivated before, and so on—which would be quite out of the question for any equipment other than a powerful tracklaying tractor and a specially built plough. And although even steam tackle would not have been of much use in this particular instance, such jobs are nevertheless typical of the heavy work with which agricultural contractors have been associated ever since steam ploughing began. But by no means all the operations described were as heavy as this—and the lighter work, most of it within the capacity of an ordinary farm tractor—is even more typical of the agricultural contractor of to-day. Just how many contracting firms there are, up and down the country, is quite unknown; and it would certainly be in the best interests of agriculture if some kind of central register could be set up. In the meantime this article is based on information supplied by ten typical contractors, whose work lies in perhaps 25 different counties, and who range from a man with three tractors to one with twenty-three. Each of these gave detailed particulars of the tractor and implement equipment available, the classes of work undertaken, and the average prices charged, while several added interesting comments, not only on their own work, but on contracting in general.

Scope of Contract Work. Leaving aside special jobs like gyrotilling, drainage and ditching, which will be dealt with separately, the most striking feature of the information

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supplied was the extraordinary wide range of operations covered. Ploughing and cultivating, of course, figured in every list, while mowing and binding were included in most of them. But, in addition, the work regularly undertaken included practically every ordinary farm operation—whether in cultivating, haymaking or harvest—with only one conspicuous exception: inter-row cultivation. That the latter should be excluded is not surprising: equipment is expensive in relation to output, while the work itself would depend too much on the preliminary preparation of the seedbed and the accuracy of the drilling. One contractor did, however, include ridging land ready for potato planting. From a study of the lists as a whole the two main functions of the contractor of to-day are evident. These are, first, to make mechanical power available to the small-scale farmer at the times when it will be of most value to him; and secondly, to give all farmers, whether they already use tractors or not, the benefit of a much wider range of modern equipment than they could provide economically for themselves. The importance of the first of these functions is obvious enough, for there are few farms so small that mechanical power could not bring about substantial economies—if it were not for the heavy capital expenditure involved, and the difficulty of spreading the resulting overhead charges over a necessarily small output of work. In effect, the contractor makes it possible for the small farmer to deal with his land as if it were part of a larger holding, capable of being equipped on modern lines.

In the long run, the second function is equally important because not even on the large-scale mechanized farm can the regular equipment include all the special-purpose implements that are available to-day. Thus, one contractor mentions that he uses four distinct types of plough—general purpose, deep-digging, colonial and disc—and that each is liable to be in demand according to the special requirements of the crop or the season. Again, grassland rejuvenators, spraying machines, rotary cultivators, pulverator ploughs, subsoilers, beet lifters and circular saws all figure in the contractors' lists and are available when required. All these implements come within the scope of ordinary farm practice at one time or another, yet few farmers would have work enough to justify the purchase of any one of them. And, finally, there are all the heavy jobs that have been the contractor's prerogative for a hundred years or more: bursting up heavy land for

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fallowing, mole draining, ditch digging and clearing, pond cleaning, hedge pulling and so on. For most of this work either the gyrotiller or the high-powered tracklaying tractor is the modern substitute for steam power, but for some of it even to-day steam tackle is better than anything else, and it is to be hoped that the hundred-odd sets still in use will not share the fate of the thousands that have been given up.

Costs of Contract Work. Having regard to differences of soil and conditions, one would have expected to find large variations in the prices quoted by different contractors for ordinary farm operations. In point of fact, however, as the following table shows, prices in different neighbourhoods were very similar. The figures given include the highest and lowest estimates in each instance, excluding any that were accompanied by a special condition or reservation. Thus, one man who operates in a district in which heavy land is still under cultivation mentioned that his price for ploughing really heavy clay might be as high as 22s. 6d. per acre; but the price for the average work which he does is within the range given. For purposes of comparison the table also gives some average costs recorded by the Agricultural Economics Institute on a number of farms which operate their own tractors.*

COSTS OF ORDINARY OPERATIONS PER ACRE		
<i>Operation</i>	<i>Range of Contractors' Costs</i>	<i>Range of Farm Costs</i>
Ploughing	12s.—16s.	7s. 8d.—14s. 5d.
Cultivating and Disc Harrowing ..	5s.— 9s.	2s. 6d.— 4s. 6d.
Harrowing and Rolling ..	1s. 9d.— 3s.	2s.— 3s. 1d.
Drilling or Manure Distributing ..	5s.— 6s.	—
Mowing	2s. 6d.— 7s.	—
Binding	6s.—15s.	—

The main point arising from these figures is the very small margin between the contract price and the costs shown by farm records. Only in cultivating is there any marked difference and this is perhaps the one operation in which one would expect the contractor's generally heavier tractor and implement to do a more effective job of work. It is true that on completely mechanized farms operating costs might be appreciably lower than those given in the table, but it is equally true that the latter are more representative of average

* *Studies in Power Farming II. The Cost of Tractor Work.* By J. R. Lee, Agricultural Economics Research Institute, Oxford.

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farming. Moreover, it should be remembered that, whatever may happen, the price quoted is all the contractor gets, while farm costs, on the other hand, are generally estimated on the assumption that nothing very serious will happen to tractor or implement for some time to come. Or as one contractor put it: "Many farmers hire because they then know exactly what their costs will be, and if the tractor breaks down or blows up they can regard it with tolerance if not with affection." But be that as it may, the prices quoted for contract work clearly include no extravagant charges for either travelling, overheads or profit.

Incidentally it may be mentioned that occasionally one hears complaints that contractors are losing business to farmers who take on outside sparetime work at cut prices, and one suspects that the real cause is that the latter do not really know what their own costs are. After all, no farmer in his senses would cultivate even his own land for the bare costs of the work without regard to the profit which he hopes to make out of the crop; and whether the outside work is done as a spare time occupation or not, a corresponding margin over and above actual expenses should be charged.

Before leaving the subject of costs it should be pointed out that these are not always calculated on an acreage basis. Most contractors are equally prepared to work on a time basis—charging from 4s. to 10s. per hour for tractor, driver and implement, according to capacity—while some are also prepared to hire out special implements for use with farmers' own power units.

And, finally, a few figures may be given to illustrate contract charges for work outside the ordinary range of cultivating operations—with the reservation that, in practice, every such job is made the subject of a special inspection and quotation:—

Gyrotilling : 33s.-40s. per acre according to area concerned.

Ditch cleaning with dragline : 10s.-15s. per chain each side.

Mole draining : 10d. per running chain or, at ordinary spacings, 20s.-25s. per acre.

Subsoiling : 25s.-30s. per acre.

Bursting-up land for fallow with heavy cultivator : 25s.-30s. per acre

Conclusion. From the above very rough sketch of the present-day contractor's activities it will, one hopes, be realized that he renders a very essential service to agriculture. At all events it would be very wrong to regard the contractor

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simply as one more among the army of people who have something to sell. The genuine contractor is very much more than this: he and his men represent valuable experience which is at the service of the farmer; his equipment represents a capital investment in which any farm can share. Or as one contractor put it: "It has always been my aim to make my tackle of real use to my customers, and for that reason I place it entirely at their disposal and the driver under their direction. In other words, when my equipment is on their farms they can use it as if it belonged to them—and some of them have been doing so ever since I started in business twenty years ago."

CANADIAN TYPES OF FARMING

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Many types of farming are engaged in by Canadians in the various agricultural regions of the Dominion. On the one extreme is wheat production, which predominates in large areas in the Prairie Provinces; on the other are the intensified operations connected with small fruits, market gardening, and tobacco, such as are carried on in Southern Ontario. These variations in types of farming result largely from differences in soil type, climatic conditions, and location with respect to markets.

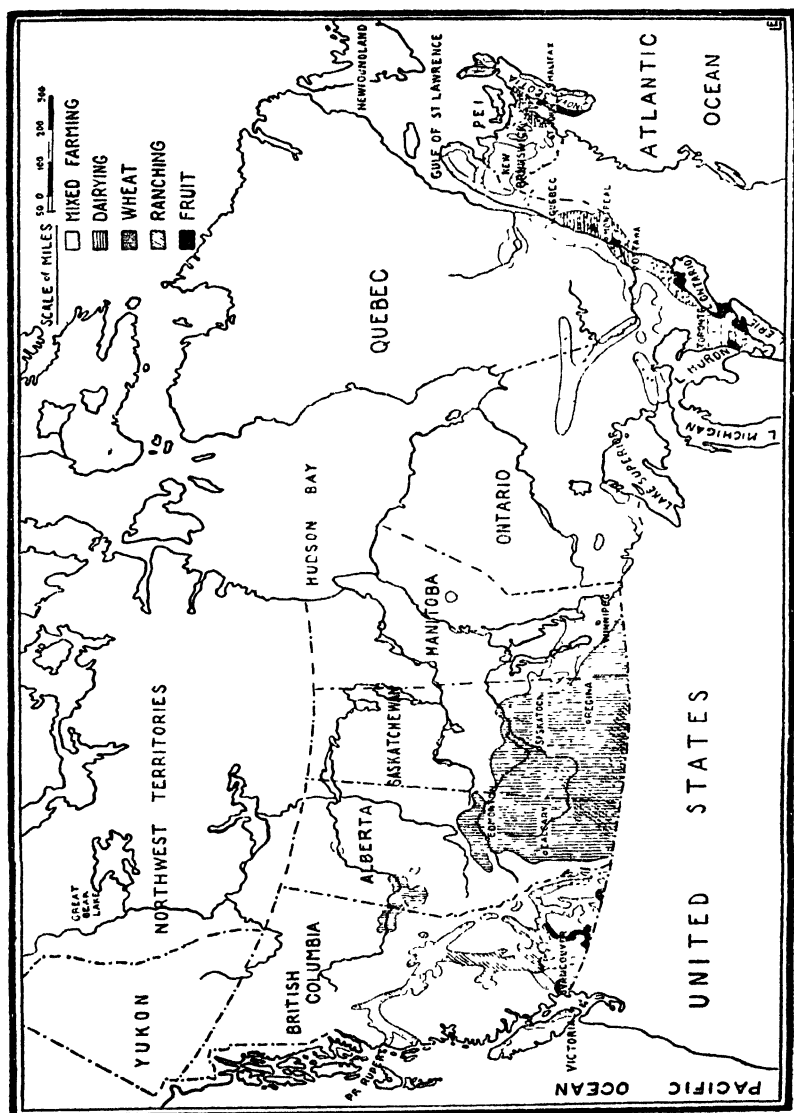
With the exception of the Maritime and Central Provinces, there is little uniformity or continuity of agricultural areas, as may be seen from the accompanying map showing the main types of farming. In most instances, the agriculture of the Canadian areas resembles fairly closely that of the areas of the States adjoining them, of which they are geographically a part. The tremendous natural obstacles between the areas present serious difficulties of communication, transportation and distribution. Most Canadian agricultural areas produce more than is needed locally and the surpluses resulting have to be disposed of in outside markets, where they encounter heavy competition and meet serious political and economic obstacles.

Four important agricultural regions are readily distinguished. Starting at the Pacific coast is that in British Columbia, which is separated from the Prairie Provinces by the Rocky Mountains. Its agriculture is principally located in the mountain valleys and the coastal plains. The climate is generally mild with an abundant rainfall.

The Prairie Provinces of Manitoba, Saskatchewan, and Alberta, form a block which includes about two-thirds of the occupied farm lands of the Dominion. These lands are used chiefly for grain production. The climate is more extreme than in the other agricultural areas of Canada. The frost-free period is fairly short, rainfall is limited and variable, and the choice of farm enterprises is severely restricted by nature and markets. The agricultural lands are practically all situated in the southern half of these provinces. A large non-agricultural region extends from eastern Manitoba to east-central Ontario.

The southern parts of Quebec and Ontario are included in

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a central group. Most of the agricultural portions of these provinces are favoured with a temperate climate. Here are located the densest centres of population in Canada, where local conditions and markets have much to do with the determination of the types of farming, which are quite varied in character.

The eastern group includes the Maritime Provinces of Prince Edward Island, Nova Scotia and New Brunswick. Over this area the climate is generally temperate, favouring dairying and the growing of potatoes, and apples, and also other fruits, much of which is sold in the markets of Britain.

The average size of farm in Canada in 1931, when the last decennial census was taken, was 224 acres. The sizes for the several provinces show wide variation, the smallest farms being in Prince Edward Island and Nova Scotia, where they average approximately 92 acres. The largest farms are located in Saskatchewan and Alberta, being about 400 acres on the average. Of the 728,633 farms in Canada, by far the greatest number range in size from 100 to 200 acres, but substantial numbers fall in the size group 300 acres and over.

About 80 per cent. of the farms are operated by owners, 10 per cent. by tenants and 9 per cent. by part-owners and part-tenants.

In recent years there have been important developments in fur farming throughout Canada, particularly in connexion with silver foxes. From the silver-fox farms about one million pounds worth of skins were sold in 1936. Mink farming is forging ahead rapidly. Fur-bearing animals were kept on 8,141 farms in 1936, but on most of these farms the bulk of the revenue was obtained from other farm enterprises. There are, however, specialized fox farms in every province of the Dominion, some of which engage in production on an extensive scale.

While much statistical information might be presented with regard to agriculture in Canada, only that necessary for an adequate description of the agriculture of the recognized types of farming which have become established has been included.

British Columbia. The census of 1931 reported about 3½ millions acres of occupied land in this Pacific Province, but only 705 thousand acres was improved land, i.e., land that has been cultivated and is now fit for the plough. There were then 26,079 farms of an average size of 136 acres each.

While most of Vancouver Island is mountainous, there

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are limited agricultural areas along the south-east coast of the Island and near the city of Victoria. Here the farming is largely concerned with small fruits, vegetables, poultry-raising and dairying, while the growing of flower and vegetable seed is carried on in a moderate way. On the Mainland, there is a specialized agricultural area in the Lower Fraser Valley at the mouth of the Fraser River, near Vancouver, where dairy farming and poultry raising are the main enterprises, and market-garden produce, small fruits and potatoes are also grown. Poultry products, market garden truck and potatoes are the main types of agriculture of another coastal section nearby, the Howe Sound area which includes the district of Richmond.

In the interior of this Province are a number of valleys in which cattle or sheep ranching is practised fairly extensively. Perhaps the best known of these interior valleys is the Okanagan Valley, which lies in the southern interior of the province along the lake of that name. Here the irrigation of valley lands is facilitated by water from the mountains. In this irrigated area, apple growing is the main enterprise, while plums, pears, peaches, and cherries are also produced in considerable volume. In 1931, the apple production of British Columbia amounted to over 4½ million bushels.

Alberta. Of about 40 million acres of occupied farm land, approximately 18 million acres were reported as improved in the 1931 census. With the single exception of Saskatchewan, the farms of Alberta are considerably larger than elsewhere in the Dominion. In 1931, there were 97,408 farms of an average size of 400 acres, though many are considerably larger than this average figure.

Wheat is the main crop of the Province and is grown extensively in most areas. In some districts, coarse grains, oats and barley are grown, with which is combined the raising of a fair number of cattle and hogs.

In certain southern sections range operations for either cattle or sheep are carried on extensively, with wheat growing in the areas where topography and climate permit. Cattle ranching is particularly important along the south-western part of the Province at the foothills of the Rocky Mountains.

The most northerly agricultural area of the Province is the Peace River district, in which wheat growing predominates, although cattle and hog-raising have also been developed.

Saskatchewan. The area of occupied farm land in this

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Province in 1931 was 56 million acres, 34 million acres of which were improved. There were then 136,472 farms, of which the average size was 408 acres.

Saskatchewan is primarily a wheat-growing province and this is particularly true of the central plains, where the farms are given over almost exclusively to this crop. A few farms in the vicinity of the larger cities maintain dairy cattle and cater to the nearby demand for market milk. The south-eastern section of the Province has a somewhat more diversified agriculture than the plains area, for here coarse grains are grown also and live stock becomes a more important factor in the farm business. In the north-east, general farming is carried on with a background of wheat production, and in some areas, hogs are becoming of increasing importance. In the extreme south-west, where rainfall is comparatively low, cattle or sheep ranching types of farming have been built up similar to that of the adjoining area of Alberta, but here, too, a considerable area is devoted to wheat growing.

Manitoba. The area of occupied land in 1931 was 15 million acres, of which $8\frac{1}{2}$ million acres were improved. Farms are generally smaller in Manitoba than in the two other Prairie Provinces, and here the 54,199 farms in 1931 averaged 279 acres each. Farming had its beginning in Manitoba at a much earlier period than in the more westerly provinces, and a more diversified type of farming is to be found there than in Saskatchewan or Alberta.

Only in one area, that near the centre of the southern edge of the Province, sometimes known as the Glenboro Plains, does wheat tend to predominate, and even here there is a considerable acreage of feed grain grown to support the fairly large livestock enterprises to be found on the farms in the area. In the vicinity of Winnipeg, dairying, poultry-raising and potato-growing are practised, and in the district around Shoal Lake, north-west of Winnipeg, general farming, dairying, grain and hog production are the main sources of the farm income.

Generally speaking, the climatic and soil conditions make Manitoba less dependent upon wheat and ranching than are the other Prairie Provinces, and a type of farming has developed which is something of a mixture of the Prairie farming and the diversified agriculture to be found in the Eastern Provinces.

Ontario. The south-eastern part of Ontario, bordering the

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Great Lakes, has been developed agriculturally for many years, but the more northerly areas are still in course of development. In 1931, of the 23 million acres of occupied farm land, about 13 million acres were improved, on which there were 192,174 farms averaging 119 acres each.

It is not possible to take any one type of farming as representative of the farms of Ontario, but some diversification of farming is general. Wheat is not usually grown to any extent as a cash crop. Some cows are to be found on most farms, and dairying is practised extensively in many areas adjacent to numerous cities and urban centres. Hogs are usually included on these farms and poultry is found generally, although in varying degrees of importance.

The mild climate in the Niagara Peninsula favours fruit-growing and vegetable production, while the counties on the shore of Lake Erie produce market-garden crops, tobacco, corn, sugar-beet, orchard crops and produce for canning. In the counties on the shore of Lake Ontario, in which climatic conditions are somewhat less favourable, the production of orchard and canning crops is generally combined with the keeping of poultry, dairying or mixed farming.

Near Toronto and Ottawa are fairly well defined areas on which the farmers cater to the city demand for dairy produce, market-garden truck, potatoes and other vegetables, and poultry. In the general inter-lake region are several large areas in which beef-raising is important. These were among the earliest settled portions of the province. Long-established dairying districts are also located in this part of Ontario in and around Oxford county, and in Dundas county around the western tip of Lake Ontario, where cheese-production predominates.

In the most northerly agricultural areas of Ontario new settlements are being developed. Generally, the types of farming feature live stock and livestock products, coarse grains, hay and potatoes, with some dairying for the local trade.

Quebec. Apart from some areas in the northern fringe of the agricultural area of the Province, where the farming is of pioneer type, the agriculture of Quebec is concentrated on both banks of the St. Lawrence River. In 1931, Quebec had 135,957 farms of which the average size was 127 acres. Seventeen million acres of farm land were occupied, of which nine million were improved.

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As in Ontario, the farming is well diversified. The climatic conditions along the shore of the river lend themselves generally to such farm enterprises as dairying, poultry-raising and hogs. There is a fairly well defined area where tobacco is grown, which is largely of the pipe and cigar varieties, although the production of the "Virginia" cigarette varieties has recently been undertaken. In the vicinity of Montreal there is a highly-specialized area where small fruits, apples, vegetables, potatoes and poultry are the main farm enterprises. Some of the districts bordering the United States specialize in dairy farming. The more easterly part of the farming area of Quebec tends toward beef production. Maple syrup and sugar are quite important supplementers of the farm income in many sections.

In addition to receipts from farming operations, the income derived from the sale of pulpwood is of importance to many farmers in certain districts of Quebec and of New Brunswick, and to a lesser degree in Nova Scotia.

New Brunswick. Of the four million acres of occupied farm land in New Brunswick, 33 per cent. were reported as improved in the 1931 census. The average size of the 34,025 farms at that time was 122 acres, but much of the land still remains in woodlots.

Potatoes are of major importance in this Province, and throughout the upper St. John Valley specialized potato-growing predominates. The large area of central and north-eastern New Brunswick is not essentially an agricultural region, for most of the farms here are small and the operators often have some outside employment to supplement their incomes.

Farming in other parts of New Brunswick largely centres around live stock, the main products being dairy cattle, hogs, feed grains and potatoes. In the Moncton area, at the south-eastern corner of the Province, particular attention is directed towards hog-raising and dairying. A small apple-producing area is located in the lower St. John Valley.

Nova Scotia. Of over four million acres of agricultural land occupied in 1931, only one-fifth was reported as improved. There were 39,444 farms, the average size of which was 109 acres.

The climate is moderate, with abundant rainfall. Field crops are not of major importance in Nova Scotia, and the agriculture of the Province centres around apple production

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and dairy farming, with which a small amount of potato-growing is usual. In 1930, nearly five million bushels of apples were produced in the Province of Nova Scotia, 780,360 bushels coming from the Annapolis Valley, which is now famous for its orchards. Live stock, poultry and potatoes also contribute to the incomes of the farmers in this area.

In the north-west section adjoining New Brunswick is a general mixed-farming area producing live stock, coarse grains and potatoes. The central section is largely a mixed-farming area with some specialization in dairy production. Hogs, sheep, potatoes and roots are also found in this area. Much of the remainder of Nova Scotia is unsuitable for agricultural production, but some farming, mostly of a part-time nature, is carried on along the east coast of the Province and on Cape Breton Island. Dairying is the most important source of income on these farms.

Prince Edward Island. Although the smallest of the Provinces, Prince Edward Island is quite important agriculturally, partly because of the very large proportion of the total area which is suitable for farming. There were 12,865 farms in this province in 1931, their average size being 92 acres. Ninety-five per cent. of the farm land was occupied, the improved farm land in that year being about three-quarters of a million acres, which is only slightly lower than the acreage improved in Nova Scotia.

The type of farming is quite similar in all districts and includes dairying, potatoes, hogs, poultry and sheep. There is a tendency to specialize in potatoes and turnips as cash crops. The Province has a reputation for fox farming, which has become an important enterprise on many farms on "The Island," as it is affectionately termed by its inhabitants.

This brief summary of "Types of Farming in Canada" omits much of interest but serves to give a bird's-eye view of the agriculture of a vast country having a wide variety of natural conditions, in which farming areas are at varying stages of development. The growth and expansion of Canadian agriculture depends on the possibility of securing satisfactory markets for the products of the farms, and these in turn are dependent on the purchasing power of the people of the Dominion of Canada—and also on that of the people of the other countries which purchase Canadian agricultural commodities, of which Britain is by far the most important.

IMPROVEMENT OF CARCASS QUALITY IN PIGS

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There is an old saying that "Half the breed goes in by the mouth." Exactly why this should be so and how it is brought about was made clear by some experiments which were carried out in an attempt to control the body proportions and composition of the bacon pig.* A brief account of these experiments is given below.

In order to obtain a uniform set of animals for the purpose of this experiment, an inbred strain of pedigree Large Whites was established by breeding together brother and sister selected from a strain on the University Farm, Cambridge; this strain had been giving good fertility, rearing and grading results. All the pigs used in this experiment, some 80 altogether, were the offspring of these two pigs, or their progeny up to the fourth generation of inbreeding.

Normal Growth Changes. At first a study was made of the way in which the body conformation and the proportions of muscle, fat and bone in the carcass change as the pig grows up.

Pigs were killed at monthly intervals from birth to bacon weight at 7 months old; body outlines were photographed, and the different organs and joints of the carcass were weighed. In each joint the muscle, fat and bone was dissected out and weighed separately; chemical analysis of different regions was also made.

The main conclusion reached from this series is that as the pig grows up the body shape changes (see Fig. 2). At birth, the body is short and shallow with a high proportion of head, neck and legs to loin; the body then lengthens out and the

* McMeekan, C. P., 1938. *Growth and the development of carcass qualities in the pig*. Thesis. Cambridge. Full details are given in this paper which it is hoped will be published shortly.

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proportions of the loin—a high-priced joint—in relation to head and neck—low-priced parts—increases; later, the body deepens and thickens so that now the proportions of the head and lower parts of the legs (low-priced parts) are small in relation to the rest of the body. The changes are brought about by waves of growth which start at the extremities—head,

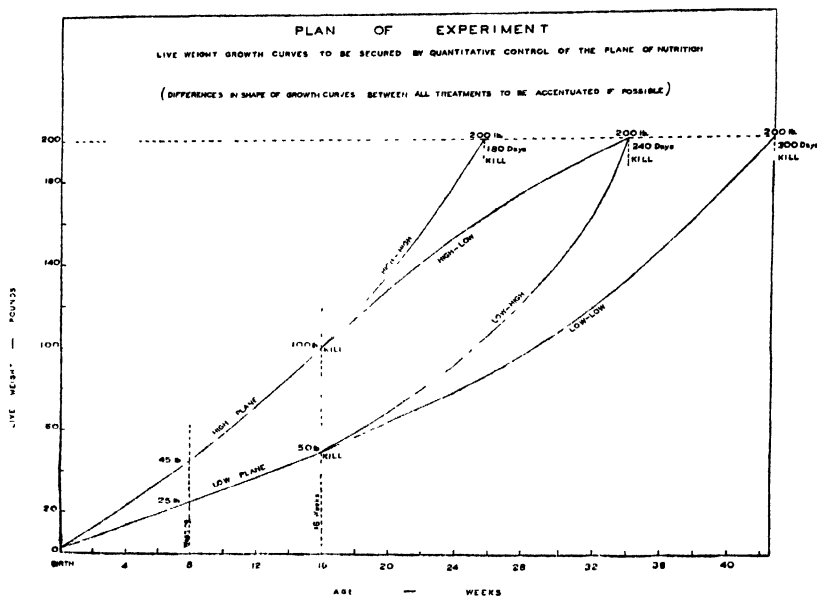


FIG. 1 — Plan of Experiment

legs and tail—and spread to meet at the loin, which is the latest maturing part of the body. Similarly, changes take place in the composition of the carcass as the pig grows up; these are shown in the following table:—

Age	Live Weight (lb.)	Percentage Composition of Carcass*		
		Bone	Muscle	Fat
Birth ..	3	25	39	5
16 weeks ..	80	14	46	26
28 ..	220	9	39	43

* The balance of the 100 per cent. being skin, tendon, etc.

It will be seen that bone develops first, followed by muscle, while fat is a tissue of the body which develops later in life.

IMPROVEMENT OF CARCASS QUALITY

Plan of Experiment. With this knowledge, an experiment was planned to find out how the normal changes in proportions as the pig grows up could be changed so as to produce those proportions which the pork butcher and bacon manufacturer require. The question to be answered was—could we, by making the pig grow well in early life when the frame and muscle were being developed, intensify the development of these parts in the carcass; and could we, by stunting the young pig at this stage of growth, followed by heavy feeding and quick growth at a later stage of life when the fat was developing most, get reduction of the frame and muscle and produce an excess of fat on the carcass?

To test this the pigs were made to grow along predetermined growth curves (Fig. 1) by controlling the *amount* of the food intake, the quality of the food being the same for all the pigs—high in proteins, minerals and vitamins.

At birth, each litter was divided into two; half were made to grow slowly (Low Plane group) by removing them from the sow for 8 hours or more each day so that they did not get much milk, while the other half were made to grow fast (High Plane group) by supplementing the sow's milk by creep feeding with skim milk and high protein dry feed. After weaning at 8 weeks old, the High Plane group were made to grow as fast as possible while the Low Plane group were rationed so as to grow according to the predetermined growth curve (Fig. 1).

At 16 weeks old, each lot was again divided into two. Half the pigs which had been on a Low Plane feeding (and which at this time weighed about 37 lb.) continued on a Low Plane (Low-Low) until they reached 200 lb., while the other half were changed over to a High Plane nutrition (Low-High) and were made to grow as quickly as possible to bacon weight (200 lb. live weight). Similarly, half the pigs which had been on High Plane feeding (and which at this time weighed about 113 lb.) were continued on a High Plane feeding (High-High) until they reached 200 lb., while the other half were individually fed and rationed (High-Low) so that they reached 200 lb. bacon weight on the same day as their litter mates of the Low-High group.

The actual results obtained were rather better than shown in Fig. 1. The High-High group reached bacon weight (200 lb.) in an average of 165 days, the High-Low and Low-High groups reached it in about 211 days, while the Low-Low

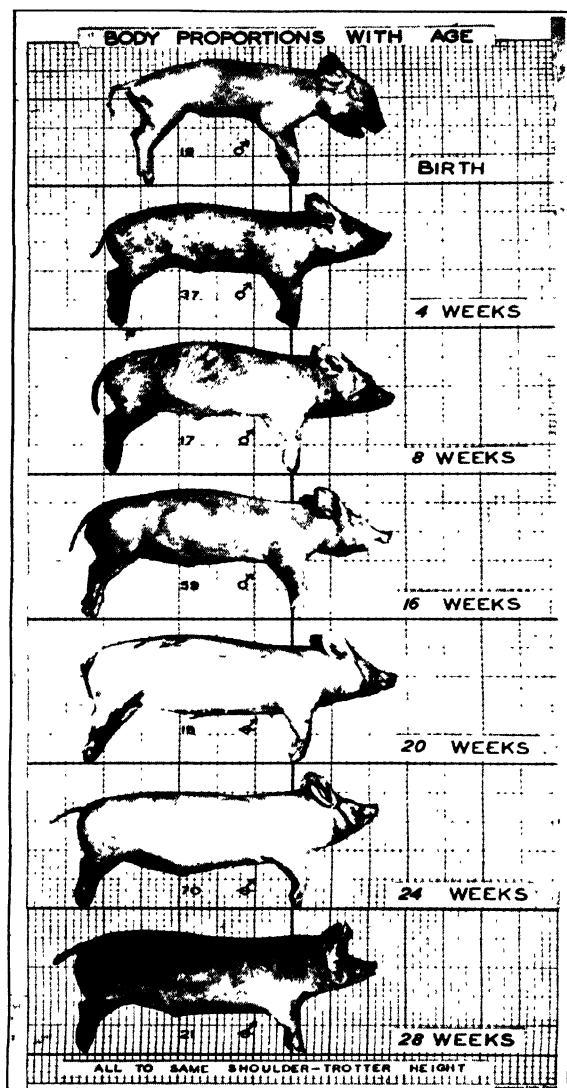


FIG. 2 Changes in the conformation of the pig as it grows up. All photographs reproduced to the same shoulder-trotter height so as to show changes in shape as distinct from changes in size.

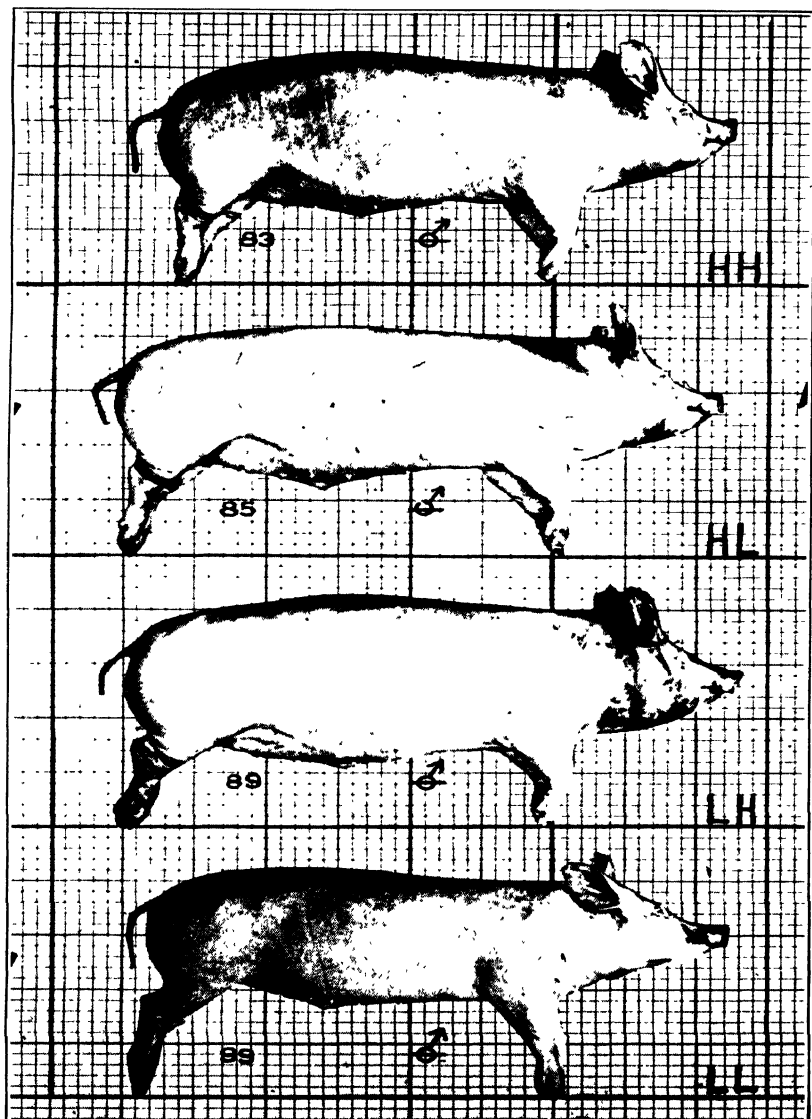


FIG. 3 Pigs of bacon weight (200 lb) grown at different rates. All photographs reproduced to the same shoulder height so as to show the proportions in relation to height. For details of pigs, see Fig. 5.

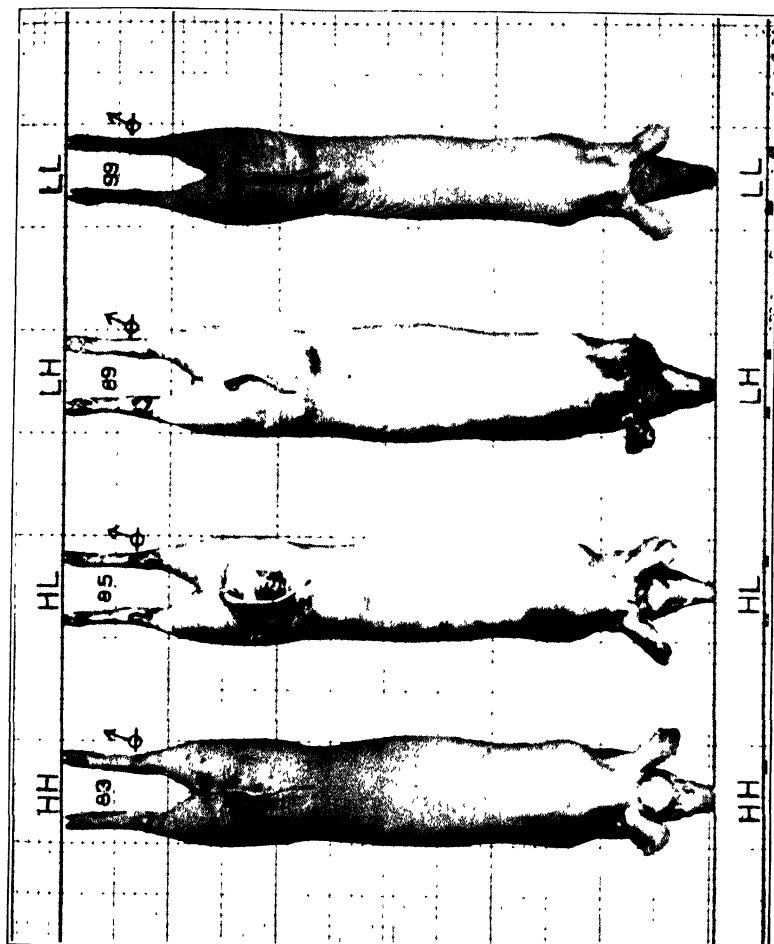


Fig 4 —Carcasses from pigs of bacon weight grown at different rates. All photographs reproduced to same length in order to show body proportions. For details of pigs, see Fig 5

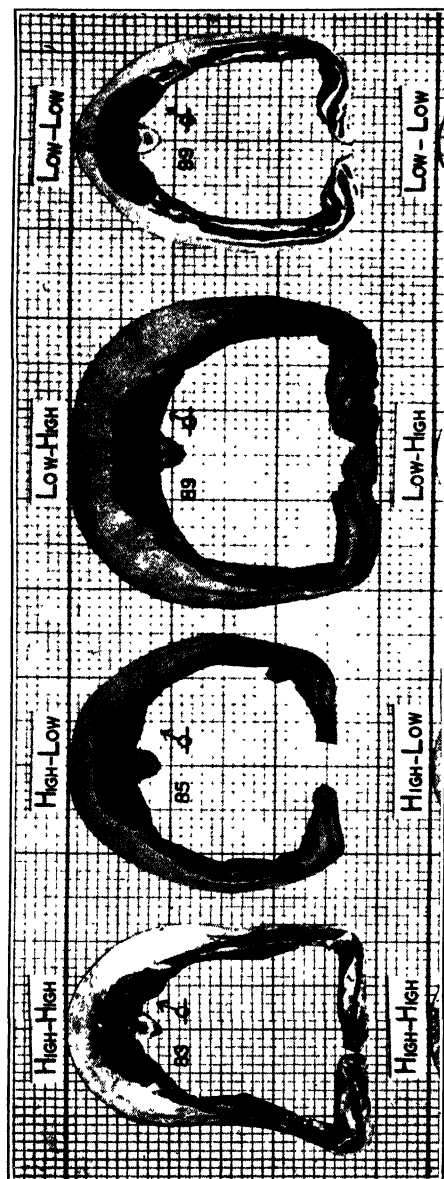


FIG. 5.—Cut through the last rib of bacon pigs grown at different rates. All photographs reproduced to the same "eye muscle" length

83 H-H	Quickly grown throughout.	168 days old
85 H-L	Quickly grown to 16 weeks, afterwards grown slowly	196 days old
89 L-H	Slowly grown to 16 weeks, afterwards grown quickly.	196 days old
89 L-L	Slowly grown throughout	315 days old

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group did not reach it until they were about 327 days old. All the pigs were slaughtered, photographed, measured and dissected as they reached 200 lb. live weight.

Results. Let us first compare the pigs which were made to grow fast all the time (High-High), and which reached bacon weight in 165 days, with those that were made to grow slowly (Low-Low) and which only reached bacon weight in 327 days. By putting the animal on a high plane of nutrition and making it grow fast, the full development of the later growing parts of the body is caused; in contrast, in one which is grown slowly the early developing parts of the body continue to grow but the later growing parts are comparatively under-developed. Thus the fast growing animal becomes blocky (Fig. 3, H-H) and the slow growing animal rangy (Fig. 3, L-L); the fast growing animal has a high proportion of loin to head and legs (Fig. 4, H-H) while the slow growing one has long head and legs in proportion to its body and the ham is not so well filled out (Fig. 4, L-L). The fast growing animal thus gives a much higher proportion of meat (muscle and fat) to bone than the slow growing one. This fast growing blocky pig with a high proportion of loin to head and meat to bone is the type of animal the pork butcher wants. These pigs were, of course, above pork weights, and so in the fast growing pig there was at this weight rather too high a proportion of fat to muscle (Fig. 5, H-H), but in the pigs of this group that were killed at about 115 lb. at 16 weeks old the proportion of fat to muscle was about right. The composition of the carcasses at bacon weight were as follows:—

<i>Group- Growth Rate</i>	<i>Live Weight (lb.)</i>	<i>Percentage Composition of Carcass*</i>		
		<i>Bone</i>	<i>Muscle</i>	<i>Fat</i>
Fast (H-H)	.. 200	11	40	38
Slow (L-L)	.. 200	12	49	27

* The balance of the 100 per cent. consisting of skin, tendon, etc.

Now let us compare the other two groups—the pigs which were made to grow fast up to 16 weeks old and were then slowed down (High-Low) so that they reached bacon weight at the same time as their litter mates, which had been grown slowly up to 16 weeks and were then made to grow as fast as possible (Low-High). Both groups were killed at the same age (211 days) and same live weight (200 lb.), the only difference being the shape of their growth curve (see Fig. 2).

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By growing the pigs well in the early stages, good development of the frame and muscle was obtained, but, as they were slowed down in rate of growth after 16 weeks old, too much fat did not develop, but instead the muscles continued to grow. In contrast to this, in the pigs which had been stunted in early life the frame and muscular tissue did not develop properly. When, at 16 weeks, such stunted pigs were fed well and forced to grow at a great rate, most of the increase made consisted of fat, for at this time of life the daily gain possible in frame and muscle is comparatively low.

Thus the pig which is grown quickly in early life and slowed down later is of typical bacon type (Fig. 3, H-L) as compared with the lard type of its litter mate, which was stunted in the beginning but fed well later (Fig. 3, L-H). The latter (Fig. 4, L-H) had a much greater thickness in relation to its body length than the former (Fig. 4, H-L). Associated with this greater body thickness in proportion to length there was a tremendous thickness of backfat in the pigs which were stunted in early life but well fed later (Fig. 5, L-H), as compared with those which were grown well in early life and slowed down later (Fig. 5, H-L). The composition of the carcasses at bacon weight were as follows:—

<i>Group-Growth Rate</i>		<i>Live Weight (lb.)</i>	<i>Percentage Composition of the Carcass*</i>		
<i>To</i>	<i>From</i>		<i>Bone</i>	<i>Muscle</i>	<i>Fat</i>
<i>16 weeks</i>	<i>16 weeks</i>				
Fast	Slow (H-L)	.. 200	11	45	33
Slow	Fast (L-H)	.. 200	10	36	44

* The balance of the 100 per cent. consisting of skin, tendon, etc.

Conclusions. The general conclusions from these experiments appear to be that a quick rate of growth in early life, when frame and muscle are developing, gives the type of pork carcass which is in greatest demand, that is, one which has thick, well developed muscles and a small proportion of bone. For bacon pigs the best type of carcass is also produced from a pig which is made to grow well in early life—up to 16 weeks—but which is afterwards rationed so that it does not put on too much fat. This result is similar to that which was found by Mansfield and Trehane,* who obtained much better grading results by restricting the rations of bacon pigs during the last part of the feeding period. From all

* Mansfield, W. S., and Trehane, W. R., 1935. Interim Report of pig-feeding experiments conducted on the University Farm, Cambridge.

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points of view, except that of lard production, the worst type of carcass is produced from those pigs which are stunted in early life and then subsequently are fed heavily and made to grow as fast as possible.

Our results give support to the work of Pig Recording Societies who are attempting to increase the weaning weights of pigs by improvement of the sow's milk supply, creep feeding and management in the early stages of life. By doing so they are improving the quality and the thickness of lean meat in the carcass, whether the pig is subsequently to be used for pork or for bacon.

The findings also show the reason why so many bacon carcasses have in the past been too thick in backfat measurements. Young pigs have been allowed to go back in condition after weaning and get stunted, then after a store period they are brought in and put to fatten, being given as much as they can eat. This type of management produces a pig which may look well externally as a live pig in a fat-stock show, but it gives a carcass much too thick in fat and poorly developed in lean meat to meet modern consumer demand.

There are, of course, limits imposed by breed, and it is not suggested that methods of feeding can displace breed characters. The breed characters, however, can be modified considerably by the methods of feeding adopted. Breed selection is best done in the nutritional environment which develops the characters in the direction desired, for then and then only is the development of the characters limited by the breed and not by the feed.

SUMMER FATTENING OF CATTLE ON GRASS LAND

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To buy store cattle in spring, allow them to graze during the summer, and then to sell them in the autumn seems a very straightforward form of business, involving the minimum of worry and trouble as well as of labour. To the uninformed observer, it would appear to be one of the simplest forms of livestock management. Actually, it calls for a great deal of skill and judgment as well as the outlay of a considerable amount of capital, and even with the best management, the course of prices in some seasons makes it inevitable that some of the cattle should show a loss. For instance, the following statement would apply to many cattle bought as stores in the spring of 1938 and sold fat in the autumn:—

			£	s.	d.	£	s.	d.
Cost of Store beast	7½ cwt. @	50/-				18	15	0
Received for fat beast	10 cwt. @	35/-	17	10	0			
Subsidy	10 cwt. @	5/-	2	10	0			
						20	0	0

The balance is obviously quite inadequate to cover rent, labour, interest on capital, marketing and other expenses. Such an experience is not the general rule or the industry would not be continued, but the illustration serves to show that the usual drop in prices of cattle from the spring to the autumn presents a very real problem. Before discussing ways in which this is dealt with, brief consideration may be given to the conditions under which summer fattening is most likely to be successful.

Fattening Pastures. The first requirement is pasture capable of fattening cattle without heavy expenditure on purchased feeding stuffs. The best fattening pastures are capable of carrying at least a bullock per acre, and the usual expectation is an increase of 14 lb. live weight per week throughout the grazing season of about 24 weeks. Such pastures occur in many parts of the country, very often in river valleys, but the largest area in a more or less compact district occurs in the counties of Leicester, Northampton and Warwick. It

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is in these counties that the summer fattening of cattle can best be seen as a very highly specialized business.

Many attempts have been made to discover exactly what is responsible for the special property of fattening pastures. They are generally well known locally, and their reputation is well established by experience, but it is not easy to fix definite characters which distinguish them from pastures in the same district which appear to be very similar, but which will not fatten cattle without additional food. Armstrong has shown that in the Midlands the herbage of such pastures usually consists very largely of perennial ryegrass and wild white clover, and that the choicest grazing land is invariably associated with soil rich in available phosphates. But neither botanical composition of the herbage nor the chemical analysis of the soil fully account for the quality of all fattening pastures. For instance, Alun Roberts, in a survey of such pastures in North Wales, found in nearly all the fields he examined that the proportion of perennial ryegrass was much less than that of bent (*agrostis*), normally regarded as an inferior species. Probably the fattening quality is due to a combination of several factors, and it is safe to say that not the least of these is the depth and texture of the soil, on which the supply of moisture to the grass throughout the summer largely depends. Where this is satisfactory, the growth of grass will be fairly steady and even, the herbage will remain leafy and not become unduly fibrous. The importance of the right combination of chemical and physical properties of the soil probably largely accounts for the fact that so much land of fattening quality is of alluvial origin. Silty deposits from a river of any size are drawn from a great variety of origins, thus containing a comprehensive collection of items of plant food. The uniform, deep soil enables grass roots to penetrate to a great depth, and is the best medium for the retention of moisture and its regular supply to the plant. Free drainage is also an important factor, because on it largely depends early growth of grass in spring.

Management of Pasture. The maintenance of the special qualities of a valuable fattening pasture depends to a considerable extent on skilful management. Mismanagement for even one season may cause deterioration for at least the following year or two, and continued bad treatment may reduce its value almost permanently.

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The chief essential is adjustment of the stocking of the land to the growth of grass. In general, the best pastures are kept free of stock of all kinds after they have been cleaned up in the late autumn, until the following April. On dry land in early districts the grazing season may begin early in April, but, more often, cattle are not turned on to the pastures until the end of April or the beginning of May. By then, there should be a "good bite," and the land should be dry enough to carry stock without any "poaching." Grass in the early part of the season is of much greater value than that produced late in the season, so that the pasture must be given every chance to start growth in March or April. This earliness is undoubtedly another of the factors which determine fattening quality. Recent research has shown that a month's rest of the pasture in August or early September contributes very materially to the early growth of perennial ryegrass in spring. It enables the plant to build up in its roots reserves which can be drawn upon before ordinary growth has fully started.

The aim throughout the season is to have a sufficient number of stock to keep the herbage evenly grazed so that it remains leafy. On the other hand, the grass must not be grazed so bare that the cattle have difficulty in satisfying their needs or have to expend a large amount of energy in "getting a bellyfull." At first, the number of cattle turned into the pasture will be comparatively small, but, as the rate of growth increases during May and June, additional animals must be turned in. This adjustment of the stock to the pasture requires trained observation and experience as well as the command of capital to secure the additional cattle as required. It is impossible to predict the nature of the season, and in a dry year the grazier has to run the risk of being short of grass for the cattle which he has already purchased. On the other hand, in an abnormal growing season, he may have to purchase additional cattle at short notice. Of the two, the latter is probably the more difficult situation to meet. Cattle bought late in the season can rarely leave any profit. They have missed the best part of the grazing season and are being kept on a constantly falling market. None the less, they must be bought to keep down the grass.

Other points in management which receive the attention of the skilled grazier are water supplies, drains, and the cleaning up or careful spreading of the dung of the cattle so that patches of rank grass are reduced to a minimum. A Midland prac-

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tice which always strikes the visitor from other parts, is that of collecting the dung into heaps during the summer and spreading it in the following winter on the parts of the field which require it most.

Management of the Cattle. It is hardly necessary to emphasize the importance of sound judgment and business acumen in buying the right class of store, and the grazier's difficulties in this respect were indicated last month. Next to this the financial results of the enterprise depend largely on two factors:— 1. the extent to which full advantage is taken of the high value of the grass in the early part of the season; 2. the proportion of cattle which are marketed before the autumn slump in prices has set in. To a great extent, these two are connected. If full advantage is to be taken of the grass in the early part of the season, a supply of forward stores, which have been wintered in such a way as to get them into good thriving condition and to retain their hair, must be available at the beginning of the grazing season. These will fatten off quickly, and the majority will be sold before the end of July. Such stores are dear and difficult to obtain just when required, so that a common practice is for the grazier to buy them either in autumn or in winter. By so doing he obtains them at a lower price per cwt. than if he waited until April. He will either out-winter them on some second-rate dry land, supplementing the pasture with hay, or he may make an arrangement with an arable farmer to winter them for him in an open straw yard. This latter arrangement was much more common in the past than it is now. The arable farmer gave the straw, some roots and labour free. In return, the grazier lent his cattle as manure-making machines, and undertook to supply a certain amount of cake, which benefited the cattle and at the same time enriched the manure which they produced. It is by some such means as these that the grazier avoids the full force of the blast indicated in the balance sheet given earlier. He is only able to satisfy part of his requirements for store cattle in this way, but it is to these cattle, fattened quickly and marketed early on the very choicest grass, that he looks for a margin to compensate for cattle bought late in the season, which, at best, can only be expected to pay their way, and which, very often, show an unavoidable loss.

The early grass and the first crop of cattle having thus been

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disposed of, a second lot of cattle will take their place, to be fattened off as early as possible in the autumn. Such cattle will be bought in spring, but they will, usually, not compare in condition with those treated in the way described above. Some will be Irish stores, which may have suffered from long railway journeys and exposure in a number of fairs or markets, as well as a cross-channel voyage, in the course of their transit from rearer to grazier. Others may have been wintered indoors, and, when turned out in the spring, will suffer a bad check. It may be mentioned in this connexion that a good coat of hair is of the greatest importance, and the lack of this on cattle wintered in warm quarters more than neutralizes superior condition when exposed to cold spring winds. In any event, it is not likely that cattle purchased in late spring will really settle down and be capable of taking full advantage of first-rate grass for two or three weeks. It would, therefore, be wasteful to put them straight on to the fattening pasture, though a sudden rush of grass may make this necessary. They can be kept quite well on secondary land which is to be mown for hay and which need not be laid up for this purpose until well into May. They are then drafted on to better land as required to cope with the increased growth of grass in June.

In a good grazing season, many such cattle will be sold before the end of September, and the pasture will probably still carry a good growth of grass including a certain amount of rough herbage. It is most important that this should be well cleaned up before the land is finally cleared of stock for winter. For this purpose, bullocks of one of the hardier breeds may be purchased in early autumn and kept for out-wintering, first on the good pastures and then on some dry land of poorer quality.

Such a season's programme is well summarized in the account quoted by Fream* of the management of a South Midland pasture. It was written in 1890 but would apply to many of the best pastures to-day almost equally well.

I have forwarded a block of turf cut from a field bearing the best character of any in this immediate neighbourhood ; it is 46 acres in size. The last week in April I stocked it with 44 Hereford steers and 4 shire fillies ; the Herefords were all fat, and sold to a London dealer by the middle of July. I then drafted 36 other Herefords into it from inferior pasture ; they were all fat and gone by the end of August. I then stocked

* *Journ. R.A.S.E.*, Vol. 1, No. 36, p. 369.

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it with 40 Shorthorn heifers; 20 of these were sold fat at the end of October, the remaining 20, being half-fat, were put in the stalls about the first week in November. I then put in 24 Welsh runts (stores), to clean it up, and they have (February 14), until quite recently, been doing well, when I moved them into strawyards. I have never known any artificial food of any sort given to beasts in this field.

As the quotation indicates, feeders do not select their cattle indiscriminately, but vary both the breed and the type of animal according to their knowledge of the capacity of their land and the nature of the season.

For instance, for the early markets, Shorthorns and Herefords, as quickly-growing and rapidly-fattening cattle, are favoured, whilst more slowly-maturing breeds take their place for the autumn markets.

In the same way, the class of cattle is carefully adjusted to the nature of the land. For instance, much of the best land is most suited for big three-year-old bullocks. Other land is best stocked with heifers, whilst some answers best with barren cows. The fact that so much of the best grazing land appears to require big bullocks for its full utilization, is one of the chief problems of the present time. The demand for such cattle is very limited, and the "strong" grass does not appear to suit the younger beasts which are demanded these days.

The same remark applies also to sheep, to some extent. These are frequently run thinly with cattle on the fattening pastures. Formerly, yearling sheep were fattened, and left a substantial contribution towards expenses. Now, there is little demand for mutton in the late summer, and the keeping of lambs and ewes on this land presents difficulties which did not arise with the yearling wethers. Altogether, it must be admitted that the industry is passing through difficult times, and those engaged in it are not finding it easy to adjust their methods to suit altered conditions.

Summer Fattening in Other Areas. The foregoing remarks mainly apply to the fattening of cattle on recognized fattening pastures, and the production of well-finished animals for the markets of the Midlands and the South. It is necessary to make some reference to other areas where the summer fattening of cattle is of importance, though by no means the primary preoccupation of the farmer as it is that of the grazier of the Midlands.

In the North of England, especially in Northumberland and

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in many districts of the East of Scotland, large numbers are fattened on leys, which range from one or two years' " seeds " to long leys. With the latter, if the pasture is of really first-rate quality, the practice closely approaches that already discussed, and need not be further considered. On the shorter leys, and those not of first quality, a different system including supplementary feeding almost throughout the summer is commonly practised. The feeding of cattle on the temporary leys is often regarded very largely as a means of enhancing the fertility of the land for the growth of the arable crops of the rotation. This applies particularly in potato-growing districts, and considerable expenditure on concentrated food is not grudged, even though the cost makes heavy inroads into the returns obtained from the cattle. Another important consideration is that the additional feeding makes it possible to fatten the cattle quickly and to market a considerable proportion before the autumn slump in prices. The place of the cattle thus sold early may be taken by store lambs or by fresh lots of store cattle intended for finishing off indoors during the early winter.

Both in the North of England and the East of Scotland, cattle fed on leys in this way, with the addition of several kinds of concentrated foods, take their place among the best finished of the summer-fattened cattle. In most markets of the country, really well-finished cattle are appreciated and make a price which justifies the care and expense required to produce a good fat beast. In some markets, particularly in Lancashire, however, there is a good demand for leaner cattle, which elsewhere would only make a poor price. In recent years, many farmers in Wales, dissatisfied with the returns from the traditional system of store-cattle production, have catered for this demand, and large numbers of these cattle now find their way in the autumn to Manchester and other Lancashire markets.

The returns are somewhat uncertain, as such farmers, unless they raise their own stores, often feel the full effect of the seasonal drop in price from spring to autumn. But the fattening of cattle is usually one of a number of lines, and is often secondary to the production of fat lambs. Even if the cattle do not show much direct return, they keep the pastures well grazed for the sheep.

FEEDING STANDARDS FOR FARM ANIMALS: III. THE PROTEIN REQUIREMENTS

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The amount of protein included in the rations of farm animals should be sufficient to make good the constant wastage which takes place as a result of the normal wear-and-tear of existing body tissues, to supply growing and fattening stock with adequate building materials for the formation of new body tissues, and to furnish to lactating animals the nitrogenous constituents essential for the secretion of milk. If an animal were capable of utilizing its food protein for the above purposes with 100 per cent. efficiency, and if all food proteins were of equal nutritive value, it would not be difficult to formulate accurate feeding standards, since it would only be necessary to determine the wear-and-tear wastage (a relatively simple procedure) and the average protein content of the growing tissues and of the milk, and to include an exactly equivalent amount of protein in the ration. Since no animal is in fact capable of utilizing its food protein with 100 per cent. efficiency, and since the proteins derived from different foods have been found to vary markedly in nutritive value, this ideal method cannot obviously be adopted. In formulating feeding standards it is therefore only possible to arrive at a rough approximation of an animal's requirements, based on an estimate of the average efficiency of utilization and on our knowledge of the comparative nutritive values of proteins derived from a wide variety of sources.

Theoretical Requirements. It is, nevertheless, essential to secure information regarding the actual amounts of protein dissipated in normal wear-and-tear and contained in the body tissues and the milk, since such information must clearly form the ultimate basis for determining the practical requirements of stock.

As regards wear-and-tear, the amount of protein requiring replacement can be calculated indirectly from the quantity of nitrogenous substances excreted when an animal is fed on a ration which contains an adequate amount of energy but which is entirely devoid of protein. Experiments carried out at various centres on cattle, sheep and pigs indicate that the figure for each class of stock is substantially the same per

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unit of body size.* For cattle of 1,000 lb. live weight it represents, for example, between 0.2 and 0.3 lb. of protein per day, while for sheep and pigs of 100 lb. live weight the value is roughly one-tenth of this, i.e., 0.15 to 0.2 lb. of protein per week.

As regards the protein content of those body tissues which are responsible for the liveweight gains made during growth and fattening, comparative slaughter tests show that their composition depends largely on the degree of maturity of the animal. In young growing stock the gains in live weight consist largely of water, protein and ash, the proportion of protein lying between 10-20 per cent., while in mature fattening animals the liveweight gains may contain from 65-90 per cent. fat and the proportion of protein may fall to only 5-6 per cent. or even lower. The protein requirement will consequently depend on the age of the animal and on the type of liveweight increase desired (i.e., whether lean or fat tissues are aimed at).

The protein content of milk is far more constant, though it varies somewhat from animal to animal and also from breed to breed. Thus the milk of Guernsey and Jersey cows usually contains 3.5-4.0 per cent. of protein, while that of Shorthorns and Friesians not infrequently contains less than 3 per cent. An average figure for the protein content can be arrived at if the fat percentage is known, since there is generally a direct relationship between these two values. Feeding standards are usually based on a mean figure of 3.3 per cent. of protein, which is equivalent to a 3.7-3.8 per cent. fat content.

Efficiency of Utilization. In computing the practical as distinct from the theoretical protein requirements of live stock, it is next necessary to determine the degree of efficiency with which the food protein is utilized for the replacement of waste tissues and the building up of new body tissues and the secretion of milk.

The maintenance requirement represents the amount of protein required for the former function. It has already been stated that the body loses daily by normal wear-and-tear about 0.2 to 0.3 lb. of protein per 1,000 lb. live weight. A review of feeding experiments made by numerous investigators shows that a ration which allows for a daily intake of 0.6 lb.

* It is generally assumed that the protein requirement for maintenance is directly proportional to the body weight. Recent work in the United States suggests, however, that (as with energy) the requirement is more nearly proportional to the three-fourths power of the body weight (W^{0.75}).

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of digestible crude protein per 1,000 lb. live weight is adequate to maintain cattle in good condition without any substantial gain or loss of live weight. Calculated for sheep or pigs of 100 lb. live weight, this would represent a weekly maintenance requirement of about 0.4 lb. of digestible protein. These figures (which are the basis of the standards laid down in the Ministry's Bulletin entitled *Rations for Live Stock**) are therefore between two and three times the theoretical requirements, and presuppose an efficiency of 33-50 per cent. in the conversion of food protein into the protein of the body tissues. There is little doubt that for most animals and most rations the standards are unnecessarily high. In formulating such standards it is, however, necessary to allow a sufficient safety margin to meet the needs of all individuals and to allow for rations containing proteins of relatively poor quality. Moreover with most stock the maintenance requirement in any event covers only a relatively small proportion of the total protein requirement, so that any excess will represent only a minor addition to the food intake. For instance, a 100 lb. fattening sheep requires a total of $1\frac{3}{4}$ lb. of digestible crude protein per week, of which less than $\frac{1}{2}$ lb. is needed for maintenance, while for a cow giving, say, 3 gal. of milk, the maintenance requirement accounts for only one-quarter of the total protein intake. *There seems, therefore, to be no reason to suggest any reduction in the present maintenance requirements as laid down in the Ministry's Bulletin.*

Turning to the production requirements of the various classes of stock, it will be convenient to deal first with the protein standard for milk production, since the yield of protein in milk (on which the standard must be based) can be measured with far greater accuracy than the output of protein in the body tissues of growing or fattening animals. A review of recent literature shows that during the past 25 years there has been a marked general tendency to reduce the earlier standards. Between 1900 and 1912 the figure commonly employed varied between 0.7-0.8 lb. of digestible crude protein per gal.† of milk, the former value being that recommended by Kellner. Later American investigations showed, however, that these figures were substantially too high, and suggested values

* *Rations for Live Stock*. T. B. Wood and H. E. Woodman, Bulletin No. 48 of the Ministry of Agriculture. Tenth Edition now in preparation.

† Although for convenience the term gallon is used in this article, all standards are in fact calculated per 10 lb. of milk.

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approximating 0.6 lb. per gal. This figure was accepted by the Departmental Committee on the Rationing of Dairy Cows as a basis for their recommended standard, but it may be noted that in revising the older standard the Committee adopted an innovation by stating the requirements in terms of protein equivalent instead of in terms of digestible crude protein.* Since with typical production rations there is a difference of about 3-4 per cent. between the protein equivalent and the digestible crude protein, the Committee's standard was slightly higher than the American figure, i.e., 0.64 lb. of digestible crude protein per gal. Further work carried out both in the United States and on the Continent has since shown that even this figure is too high, and that it could safely be reduced to between 0.50 and 0.55 lb. per gal. Extensive feeding experiments organized by the National Institute for Research in Dairying indicate that this conclusion applies equally to English conditions, while metabolism trials at the Hannah Institute show that with rations containing good quality proteins the requirement is even lower, i.e., about 0.45 lb. per gal. The standard now generally accepted (which is incorporated in the most recent edition of the Ministry's Bulletin† is 0.5 lb. of protein equivalent per gal. of milk of 3.7-3.8 per cent. fat content. This corresponds to 0.53 lb. of digestible crude protein per gal. of milk.

It has already been stated that milk of 3.7-3.8 per cent. fat content contains roughly 3.3 per cent. of protein. One gal. of such milk therefore contains 0.33 lb. of protein, and since 0.53 lb. of food protein is required to produce this amount of milk, *the percentage efficiency of utilization of the food protein for milk production is just over 60 per cent.* This value is distinctly higher than that used in calculating the maintenance requirement, and it seems probable that, for general rationing purposes, it would be unwise to assume that a higher efficiency of food utilization could normally be attained. *The existing standard of 0.50 lb. of protein equivalent (or 0.53 lb. of digestible crude protein) per gal. may therefore be taken as the absolute minimum required for milk production unless the ration consists largely of foods containing proteins of exceptionally high nutritive value.*

* The difference between protein equivalent and digestible crude protein will be dealt with in next month's article.

† *The Feeding of Dairy Cows.* J. Mackintosh. Bulletin No. 42 of the Ministry of Agriculture. H.M. Stationery Office. Price 9d. (by post 11d.).

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Turning to the protein requirement for growth and fattening, it has already been pointed out that the theoretical requirement (i.e., the amount of protein actually contained in the new body tissues) varies with the maturity of the animal and the type of liveweight increase desired. This renders it difficult to arrive at a reliable estimate of the percentage utilization of the food protein which is allowed for in existing feeding standards. The following calculations will, however, serve to provide an approximation:—

As regards sheep, a 90 lb. hoggett requires (according to the standard laid down in *Rations for Live Stock*) a total of 1.75 lb. of digestible crude protein per week. Of this quantity 0.35 lb. is required for maintenance, so that 1.40 lb. is left to supply the requisite quantity of protein for growth and fattening. It may be assumed that the animal will not put on more than 3 lb. live weight per week. If the tissues so formed contain 15 per cent. of protein (a very rough average figure), the total protein present in the 3 lb. of liveweight gain will be 0.45 lb. This is roughly one-third of the quantity of protein supplied in the food, and therefore indicates a percentage efficiency of utilization of about 33 per cent. As regards cattle, an almost identical figure is arrived at by calculating the efficiency of protein utilization of, say, a 9 cwt. bullock receiving the standard allowance of $1\frac{1}{2}$ lb. of digestible crude protein per day and increasing in live weight at the rate of 2 lb. daily. As regards pigs, similar calculations show that the percentage efficiency of protein utilization is regarded as lying between 30-40 per cent.

These figures are markedly below that calculated for milk production (i.e., 60 per cent.), and it would therefore seem reasonable to assume that existing standards supply too generous a quantity of protein. Direct evidence of this fact is available in the results of some very recent work on pigs carried out at Cambridge, where it was found that halving the quantity of fish meal (which is commonly included in the rations of growing pigs in order to raise the protein content to the standard level) had no adverse effect on liveweight increase, leanness or general conformation. It is clearly desirable that further work on this subject should be undertaken in order to discover the lowest limit to which the protein level can be taken without affecting growth rate or quality of carcass, and that such work should embrace the requirements of sheep and cattle as well as of pigs.

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In any attempt to revise the existing standards it is, however, essential to recognize that the variable constitution of the liveweight gains of animals at different stages of maturity makes it necessary to allow a far greater margin of safety than is required for milk production, where the material formed is of relatively constant composition. Moreover, it must also be recognized that the digestibility both of the protein itself and of the other nutrients in the ration is liable to be adversely affected if the nutritive ratio (i.e., the ratio of the non-nitrogenous to the protein constituents of the food) is excessively wide, and this fact will necessarily limit the extent to which protein feeding standards for fattening can be reduced in practice. It may be noted that in general this ratio should not be wider than 1:9.

High Protein Feeding. While this discussion has so far been concerned with the possibility of *reducing* existing protein standards in an endeavour to decrease feeding costs, it must be noted that an actual *increase* in these standards has sometimes been advocated on the ground that this would result either in the production of larger liveweight gains and leaner tissues or, with dairy stock, in an improvement in the yield and quality of the milk.

Recent work tends to negative both these hypotheses. As regards liveweight gains, the most extensive work has been carried out on pigs which, by reason of their rapid growth rate, are specially suitable for such studies. Investigations undertaken at Harper Adams College over a period of some ten years have shown that neither growth rate nor leanness of carcass is improved by high protein feeding. These conclusions (which were also arrived at in co-operative tests carried out at the three Scottish Agricultural Colleges) have recently been confirmed and amplified by the Cambridge workers in a valuable series of "balance" experiments. In these experiments not only were records obtained of the individual growth rates and of the quality of the carcasses of the animals under test, but accurate measurements were made of the relative proportions of food protein retained in the body and voided in the urine as waste products. The results showed clearly (i) that the animals which received an extra allowance of protein above the normal level failed to make greater liveweight gains than those on the normal ration, (ii) that the extra protein had no influence on the leanness of the carcass,

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and (iii) that it did not improve the digestibility of the ration. It was found, indeed, that the extra protein was almost quantitatively excreted in the urine as a waste product, a fact which demonstrates clearly the uneconomic consequences which follow high protein feeding. It may be noted that gilts showed a consistently higher retention of protein than hogs, and that they also gave somewhat leaner carcasses. It appears clear from these experiments, as well as from those carried out at the other centres, *that neither growth nor leanness of tissue is altered by raising the level of protein in the food above existing standards*, but that both are dependent rather on the stage of maturity of the animal, on its sex and on its inherited capacity for growth. While the most extensive work on growth and fattening has been carried out on pigs, it may be mentioned that experiments on fattening cattle and sheep have led to the same general conclusions.

Turning to milk production, it is again found that the feeding of protein above the recognized level fails to increase the yield of milk or to affect consistently its quality. While this is apparent from the results of many feeding trials, it has recently been confirmed in "balance" experiments carried out at the Hannah Institute, where rations containing from 0.70-0.90 lb. of protein equivalent per gal. were compared with those containing the normal figure of 0.45-0.60 lb. It was found that in the periods during which the high protein rations were fed the surplus was almost quantitatively excreted as waste products in the urine, and that no improvement was found in the milk yield; in fact there was actually a fall in yield as compared with the period on the normal rations. It has already been stated that the present protein standard for milk production (i.e., 0.50 lb. protein equivalent per gal.) must probably be looked upon as an absolute minimum, since it presupposes a utilization efficiency of over 60 per cent. There are, therefore, grounds for recommending that, when high protein concentrates are cheap, the standard could justifiably be raised by, say, 10-20 per cent., namely to 0.55-0.60 lb. This would give the body an opportunity of replacing any reserves which might have been lost through prolonged feeding at a borderline protein level, particularly if the proteins of the ration were of relatively poor nutritive value. *But there appears to be no justification for raising the intake above this level in the hope that it will either stimulate secretion or improve the quality of the milk.*

MACHINE SHEARING FOR PROFITABLE WOOL PRODUCTION

DONALD MUNDAY

For the past 21 years I have been actively employed in all stages of sheep-raising in Australia. Wool-production, and the best possible way for getting the wool-clip up to prime marketable condition have been my chief objects; and in my opinion too much care cannot be taken in this matter.

In Australia we would never dream of shearing on other than a board or concrete floor, and in a wind-proof shed. All wool is properly classed in the farming area as follows:—

Main Fleece wool—AAA—AA—and A Comb (Combing).

Pieces—AA—A—and STD (stained).

The belly wool is kept separate, and also what is called Locks (floor sweepings and occasional second cuts). Nothing is thrown away.

All fleeces are thrown, shorn side down, on a wool table and well skirted; sometimes in a dry season when the dust is bad the backs are taken out, and necks containing small sticks, twigs, and leaves are also taken out. No foreign matter that will detract from the price of the wool is left in the fleece; special care being taken that all stained pieces and dags are also removed.

Each bale is sewn or clipped, stencilled with the owner's farm name, district, and description of wool, and is generally made to look as attractive as possible. All these details count a lot when the wool is displayed for auction on the wool floor.

What a contrast to the shearing conditions and wool handling methods used in this country! Surely the wool grown over here is worth better treatment than I have seen meted out to it, especially as such a small cost is necessary to enable the farmers to market their wool profitably.

During my recent travels through England and Scotland I was struck by the many and varied styles of shearing practised by the local shepherds and "clippers." They appeared very strange to me, coming from a country where machine shearing is considered *skilled labour*, where there are approximately 116,000,000 sheep, and where there is definitely only one orthodox style of shearing, the attainment of which has been the aim of hundreds of expert shearers for

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years. The shearer is paid at so much per 100 sheep; it is therefore natural that the quickest method of shearing a sheep properly is employed.

I was surprised to see the shearing of sheep out in the open, without a floor, or sometimes without even a level place to shear on, the wind blowing all the small pieces of wool away, and only the main fleece kept for sale. Not only is this open-air shearing hard on the shearers' backs, but the practice seemed to me to be merely just one way of throwing money away.

Even though the wool in this country is inferior to the fine wools of Australia, there is no reason why the farmers here should not receive full value for their product, and I think a little more care exercised at shearing time would ensure them this.

Although sheep in England are not bred mainly for wool production alone, there could and should be a fair margin of profit for the sheep-breeder from his wool-clip. To this end, a shed with a wooden or concrete floor should be cleaned out or kept apart for shearing-time; in this way none of the small pieces of wool would be lost (these pieces on Australian farms all help to pay the freight on the wool-clip). A table (6×3 ft.) should be made with $1 \times \frac{1}{2}$ in. slats placed 1 in. apart to allow all small pieces of wool to fall through. After skirting the fleece on this table and removing the dirty and stained pieces, the clean fleece is rolled up and put into a bin or packed straight into a bale. If put into a bin, the farmer could easily classify it into:—

AA FLEECE—Longest and brightest staple, finest texture, and

A FLEECE—Inferior to AA.

Pieces could also be classed as:—

A PIECES—Longest and brightest, the best,

STAINED PIECES—As A, but discoloured, and

PIECES—Floor sweepings.

It is the ambition of nearly every lad on an Australian sheep farm to become what is termed a "Gun Shearer," and, if possible, to "Ring" the State to which he belongs, i.e., to hold the State record for one year at least. This also was my ambition and many pints of perspiration I lost in achieving it. For the first seven years of my shearing career, I was imbued with the mistaken idea that the blades were the superior implement, and I worked like a Trojan during that

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time for a highest daily tally of 96 sheep (a day's work in Australia is eight hours). After once using the power machine, however, I quickly realized its superiority.

Although the same opportunities for shearing are not available in this country as in Australia, there is, however, no reason why correct methods should not be employed; this article has been written not to produce champions, but to give the pioneer machine shearer a guide to the correct holds and shearing blows that make for clean fast shearing. These holds and positions are absolute essentials in machine shearing, for the simple reason that with the power plant you *must* keep the sheep up to the machine, and within easy swinging distance from the tube. With the blade, however, you could follow your sheep all over the field.

When the machine shearer has made himself familiar with this style of shearing, he will find at once that the job is much easier and quicker; and the shearing season will be looked forward to, not as a season of irksome toil—as of old with the blades—but with pleasure, when, with fair speed and good workmanship, the owner, shearer and sheep will respond favourably to the power unit.

Freedom from cuts, and cleanliness are the standard features on which a gun shearer is judged, and considerable attention should be paid to this matter. Speed comes later with practice.

One of the greatest sources of loss in wool production is "second cuts," the second cut being worthless to the owner, and is much better left on the sheep to become part of the fleece next year. To avoid second cuts the points of the comb must be kept pressed lightly on the skin, with the back of the handpiece held up high. To do this the learner must familiarize himself with the shape of the sheep, and this can only be done by shearing—so go slow to start with. Always make sure you have control of the sheep. If they want to have a bit of a kick, let them—don't struggle with them—above all, don't lose your temper—the man who loses his temper is worse than the sheep; remember they are not supposed to have reasoning powers.

It should also be remembered that the longer each blow (or stroke) is taken, the faster the shearing will be. So get into a long sweeping style and stick to it. Always start each blow on the skin, out of the wool. Never try to push the comb through the wool, up from the skin; it won't go through.

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The handpiece *must* be down on the skin where the wool offers a little resistance. Always keep the machine in the wool as much as possible—it gets very hot cutting air.

Always catch your sheep as quietly and gently as possible. But before catching the sheep, we had better have a look at the machine. Whether electric or petrol, it should be warmed up for a few minutes before shearing; and see it is well oiled. Make sure the handpiece is properly adjusted, and *well* oiled before you start. Machines are adjusted before leaving the factory, but the user should ensure that he has a slight lead on the comb, i.e., the cutter should be set just behind the concave on the comb. The comb is designed to comb the wool before reaching the cutter, not to push it off.

In gripping the handpiece, don't hang on as though it were a crowbar. Hold it lightly between the fingers and thumb, not hard in the palm with the thumb underneath, but with the thumb on the side, and well forward; in this way there is complete wrist freedom and proper handpiece control—this is most important.

Set the sheep up as straight as possible, practically on your feet, which should be about six inches apart. Hold the sheep tightly just under the forelegs with your knees; now raise your body slightly and put the hoof of the sheep's right foreleg just above your left hip, then bend down (as if you were Don Bradman about to bat) and you have the sheep in a kind of a press, with your knees holding the skin tightly across the belly, and both hands are free for shearing. The shearing tube (or shaft) should be about eighteen inches to your right and about six inches to the rear.

The first blow is taken from the base of the right foreleg where there is a bare patch of skin. Start on this and run the comb into the wool *while the points are on the skin*—you will find it much easier to start this way—down to the right flank, then break out. Clear the brisket by shearing downwards. It is dangerous to shear towards your face; avoid doing this at any time. Now go down the same on the left side and break out at the flank. This leaves a square patch to take off the belly, which can be shorn by using either down or across blows. The left hand should always be free to keep the skin tight when shearing. Note the easy position shown in Fig. 1 with belly wool thrown clear.

When the belly is finished, the sheep is allowed to fall slightly back on its rump for cleaning out the crutch. (See

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Fig. 2, and note the position of belly wool in relation to Fig. 1.) Two blows down the right leg will usually suffice; then two more up the left leg. (See Fig. 3.)

You now bend the sheep's right foreleg and slip it down behind your right leg, thus turning the sheep slightly on to its right side; in this position you shear the first hind leg. (See Fig. 4.) Grip the sheep's flank with your finger and thumb and press firmly till the leg straightens out; now shear from the point of the leg right down to the flank; continue these blows—shuffling back slightly to allow the sheep to lie more on its side—till you reach the tail (as Fig. 4). Nearly always it pays to shear the tail when in this position, especially when the sheep are dirty or have a long tail. Here the shearer must be careful to keep the points of the comb on the skin, to prevent second cuts when starting the long blow later.

Now for the change over, and the positions that make for speed. To do this, step one pace forward with the right foot and put it between the sheep's hind legs (the sheep's right foreleg is still behind your right leg), then sit the sheep up as straight as possible, with your left leg just a little in front of the backbone and your right leg straight down the sheep's belly from the brisket to the crutch. Hold very firmly with the knees, and you have the sheep in a vice-like grip. (See Fig. 5.) This may sound a little complicated, but with practice becomes very easy. Note the easy stance of the shearer. Holding the sheep's jaws with the left hand, and bending the neck below your left knee, shear from the brisket to the jaw, slightly to the right of the gullet. (See Fig. 5.) Continue up the left side of the neck, rolling the head towards you, till you have cleared around the left ear (see Fig. 6) and have reached the point of the shoulder. Now keep control of the head with your left elbow as shown in Fig. 7, leaving the left hand free while shearing the left foreleg. A few short blows now made towards the backbone, making sure all the time to keep points of comb on skin to prevent second cuts, and you are now ready for the long blow. (See Fig. 8.) As these are the blows that shift the wool off quickly, it will be understood that as little time as possible should be spent on the first hind leg, opening up the neck, and the left foreleg.

It is very important before laying the sheep down for the long-blow position to make sure that you are in position with the shearing machine. You should still have the sheep in the same grip as when you opened up the neck. Now use a

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shuffling sort of walk, twisting the sheep to the right, till you have the tube right opposite its hips. When laid down, the sheep's body should be practically parallel with the shearing machine. If you have the correct grip, with the sheep sitting practically upright, it is quite easy to make this turn; in fact, after a little practice, the turn is made while shearing the left foreleg, thereby losing no time.

Hold the sheep as in Fig. 9, with the left foot well under its shoulder, the right knee slightly pressing in crutch, the left foreleg held with the thumb and first and second fingers, with the third and little fingers pressed against the sheep's jaws. Three or four short blows shear the wool off the ribs. Now lift the right leg and place knee on top of sheep's left hind leg (see Fig. 10), turning the sheep slowly towards you and keeping the skin tight. Make sure when in this position to keep a firm grip of the sheep, and have your foot well under the shoulder. The first two blows now should go from where the *first* hind leg was shorn to the butt of the neck; two more blows are made from the rump to top of the head, and the last blow right from butt of tail (see Fig. 10) to just underneath right ear, and down right cheek (see Fig. 11).

It is one of the essentials of fast shearing to keep the comb full, never overlapping. There is no need to push fast, but make sure to carry every blow right through. The shear marks shown in Figure 11 indicate that the full width of the comb has been used with every blow.

Now you are on the last side. Bring your right leg close in to the sheep's rump, keeping the right foreleg trapped with your left leg, taking care not to lift the sheep up too high to start with. (See Fig. 12.) Shear with a sort of down-cross blow till you have reached the point of the shoulder; care should be taken to keep complete control of the head (see Fig. 13), for in this position, if the sheep is allowed to get its head free between your legs it is liable to kick and struggle badly.

Continue shearing till the right foreleg is nearly completed, then bring your left foot back to behind the sheep, with the knees pressing into the sheep's shoulder to prevent it from slumping too much (see Fig. 13).

When you have finished the foreleg, shear the last side with downward cross-blows till you reach the right flank. Now place the left hand on the wool of the right hind leg, press down slightly, thereby rolling the skin over, and shear one

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blow *underneath* your left wrist. In this way the flank and trimmings are cleared off the hind leg.

Now, as before on the left hind leg, grip the flank with your finger and thumb, and press down firmly. (See Fig. 14.) The leg will stick out straight and can easily be shorn. As you continue in this style let the sheep slip back more and more on its left side—making sure to keep the head up under control. You now grasp the sheep's legs just above the hock (see Fig. 15), and continue shearing until you reach the tail—when you will be able to say: "That's a good job well done."

No one can expect to become an expert shearer without practice, so don't take your first attempt to heart—have another go, you'll soon surprise yourself. The sheep that I first practised on stood a better chance of being hung in a butcher's shop than in an art gallery. To gain confidence, try the grips a few times before starting. Get familiar with the grip of the hand-piece, and the swing of the tube. Keeping the sheep in position with the machine is a great factor in easier and fast shearing, so before you start shearing, go through the whole performance of correct holds and proper blows a few times with the machine out of gear.

I have known fast shearers who learned by "shadow shearing," using the comb-brush as a handpiece. A little practice in this way gives one plenty of confidence and allows one to get to know the feel and shape of the sheep. When my brothers and I were learning, our sheep dog was conscripted for much valuable practice. He would soon let us know when the "sitting" was to be closed, and I still carry a scar for disregarding my model's desires.

In countries where the wool industry is carried out to a great extent, machine shearing has completely eclipsed the blades. So it must do in this country—for three most obvious reasons. First, the present generation will not allow itself to be harnessed to the laborious old-fashioned hand method. Secondly, machine shearing produces a much better finished article, requiring no trimming, it makes fewer cuts, and is, I consider, definitely easier on the sheep; and thirdly, machine shearing is labour saving, time saving, promotes a quicker growth of wool, and lessens the danger of fly strike.

SOIL EROSION

During the last twenty or thirty years the devastation of agricultural land, due to soil erosion which has left few countries in the world untouched, has become recognized as one of the major agricultural problems of this generation. Erosion in the geological sense, i.e., the weathering of rocks, is, of course, to be distinguished from the type of soil erosion which is here in question. The weathering of rocks has resulted in the formation of a fertile soil, though of no great depth, varying in different parts from a few inches to a few feet, on which to produce the food necessary to support the world's population—both man and beast. Remove this thin layer of soil and this planet would become barren and sterile as the moon. And it is this removal of soil which is now seen to be happening on a scale which is quite appalling. In America, in Australia, in tropical countries, notably in Africa, in China, the soil over vast areas is literally being lifted or carried away, leaving behind a desert or at the best sub-marginal land of little or no productivity. For instance, it is estimated that in a single storm, 300 million tons of Middle West soil were blown out; or again that the Yellow River brings down annually some 2,500 million tons of fertile soil washed out of the lands through which it flows. Or consider the formation of vast gullies through the agency of flood water sometimes hundreds of feet wide and very deep as in South Carolina where more than 40,000 tons of soil were washed out from a single galley in the short space of eight years.

It will not, of course, be concluded that soil erosion is purely a visitation of modern times. To it, indeed, through the advance of floods and deserts may be attributed at least in part the decline of ancient empires such as those of Carthage, Babylon, Persia. The importance of the problem for the present generation may be gauged from the fact that in the United States it is now a dominant factor in the national life, and that in South Africa, General Smuts has described it as "the biggest problem confronting the country, bigger than any politics."

What then are the principal causes which are presenting the world with a problem of this magnitude? It is not a question of fertilizers being deficient and so lowering the productive

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capacity of the soil. It is rather a question of soil stability with which is bound up the humus content of the soil. Possessed of a store of organic matter, a soil has more power to retain water and is not easily washed out, nor does it lend itself readily to being blown away. By neglect, deprive a soil of its essential quantum of organic matter and it becomes a prey to the processes of soil erosion. The most powerful agencies working for erosion are the wind and the rain, and it is not surprising, therefore, to learn that a general condition favouring soil erosion is the disturbance of "natural" vegetation without an adequate attempt to replace it. Compare the effect of deforestation—particularly in relation to the control of flood water. The forest has a thick absorbent floor, and it is rare that even a tropical rain becomes a devastating flood, even if it is not entirely absorbed. But apart from this, vegetation has a protective quality sheltering the soil from the rigours of the elements, and danger ensues if an adequate protection of this kind is not provided. In certain regions the simple neglect of soil fertility has brought devastation and ruin far and wide. In the "newer countries" it is not difficult to understand the incentives which helped to encourage this neglect of soil fertility which is now taking such heavy toll. Economic pressure or economic opportunity opened up these new lands in the 19th century to feed a growing population, and the fertility of the soil has simply been cashed. Even in the post-War period, of the 40 million acres which have been developed, much has now eroded beyond, or almost beyond, repair. "Man has enriched himself at the expense of the soil; the soil can only recuperate at the expense of man."

The remedial measures which can be taken to deal with areas which are suffering from soil erosion will naturally differ with circumstances. It is, however, emphasized that the situation in regard to an affected area must be dealt with as a whole. With this proviso it has been found in many regions that simple mechanical devices to reduce the run off of flood water, e.g., by a system of dams, are effective, and again terracing and strip farming may also be employed for the same purpose. At the same time, it is important that full use should be made of the erosion control which can be effected by plants, e.g., clover, and by judicious cropping, or by ploughing in green crops. If the soil is performing its natural biological functions of feeding and being fed by living organisms it will not in general erode seriously, and the way

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of soil recovery must be along that line. Cover crops, and particularly, good grass, are important as they serve to protect the soil from direct impact of rain and wind. These are measures of local amelioration, but where the trouble is widespread the remedies applied must be drastic and far reaching. Curiously enough, the recent movement in the direction of economic nationalism—a movement which on purely economic grounds it is difficult to justify—may have a part to play in promoting measures to safeguard and restore the fertility of the soil. Even if it is only approximately true to say, as do the authors of a recently published and most interesting world survey* of this problem, that "misapplied science has brought to the world's richest virgin lands a desolation compared with which the ravages of all the wars in history are negligible," it must be expected in view of the serious extent of the problem that the curative and control measures will be drastic: some restriction on the use of land and type of cropping would seem to be indicated, and in general the introduction of measures of control which would probably not have been thought compatible with the free competitive economy which has generally obtained in the past.

* *The Rape of the Earth, a World Survey of soil erosion.* By G. W. Jacks. and R. O. Whyte. Published by Faber & Faber. Pp. 312. Price 21s.

COST OF REARING DAIRY HEIFERS

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The policy to be adopted in the disposal and replacement of cows considered to be no longer profitable is often a difficult problem to solve in the management of a dairy herd. Although there will be a number of other points to be considered, the farmer's judgment as to the relative costs of rearing and of purchasing heifers for replacing draft cows will usually be a very important consideration when he is making a decision as to whether or not he will rear his heifer calves for the herd. It will seldom happen, however, that he will have any detailed information as to rearing costs to help him in this decision. Even if cost accounts are kept for his farm, he will get useful information only if the accounts have been kept for several years and if it has been possible to keep a separate account for the heifers born on his farm. It often happens that the heifers are reared along with bull calves or store bullocks, or that heifers are bought and sold at different ages. Hence a representative average cost of rearing a heifer from birth to maturity cannot be obtained from most sets of cost accounts.

The cost accounts kept for the farm of the Agricultural Research Institute of Northern Ireland, at Hillsborough, Co. Down, however, have been specially suitable for estimating the rearing costs of heifers during four financial years, running from April, 1934, to April, 1938, because all the bull calves born on the farm during this period were sold shortly after birth and only heifer calves were reared. Moreover, only one bunch of yearling heifers was purchased during this period, and these were bought in the last year, so that they do not seriously affect the costing of the home-bred heifers.

Description of Herd. The Research Institute occupies a 500-acre mixed farm on which is maintained a dairy herd of 60-70 non-pedigree Shorthorns of dairy type. The herd is being graded up for Coates' Herd Book, so that the home-bred heifers are valued more highly than would otherwise be the case. The herd produces tuberculin-tested milk (Grade A under Northern Ireland classification) and the adopted policy is to make it as far as possible self-contained, so that the risk of introducing tuberculosis by means of purchased cows and heifers is avoided. For this reason also as many home-bred heifers as possible are reared. The rearing policy of the farm is therefore determined by factors other than costs, but this

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affects the actual costs incurred only in that the heifer calves are of necessity, and to avoid infection, reared on Grade A milk, which is charged to them at the appropriate price.

Management of Heifers. The bull calves, and a few heifer calves, that were sold as soon as convenient after birth, consumed little, if any, milk besides the colostrum from their dams and may therefore be ignored in arriving at the cost of the heifers that were kept. These calves were all reared on the pail in single calf-boxes, their management differing little from the usual practice on a commercial farm, except that, as the Institute farm was selling a quantity of cream daily, more separated milk was usually available for the calves than might otherwise have been allowed to them. As a rule, each calf got 5 quarts of whole milk per day for the first six weeks or two months, and was then changed over gradually to separated milk, which was increased to between 6 and 8 quarts and was usually continued until the calf was about six months old. The actual age at which the separated milk was taken off varied between five and seven months, depending on the quantities available and on how the calves were doing. The calves were often kept on the separated milk for a month or two longer than usual in the autumn because they are liable to take hoose at this season. The calves were offered good hay from about one month of age, together with a meal mixture consisting of 1 cwt. bruised oats, 1 cwt. flaked maize, 1 cwt. linseed cake and 30 lb. white-fish meal, the quantities given depending on the calf's appetite. From May to September, calves that were three months old or more were turned out to a paddock during the day.

During the winter, yearling heifers were mostly tied in standings, getting a run out during the day except in very inclement weather, and having the usual kind of stall-feeding, generally including hay, swede turnips and about 2 lb. of a meal mixture such as 1 cwt. bruised oats, 1 cwt. maize meal, $\frac{1}{2}$ cwt. maize germ cake and 15 lb. white-fish meal. Good oat straw was frequently substituted for some of the hay, and mangels were sometimes fed for short periods at the end of the season. After being turned out to grass the following May, the heifers stayed out until they were about to calve. They lay out during their second winter in a well-drained field, getting plenty of rough hay or straw and a few swede turnips. Cabbage or kale was also given occasionally, and during the winter of 1937-38 grass silage and a little vetch and oat silage

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were given. The meal allowance was usually about 2½ lb. per head per day of a mixture such as 2 cwt. bruised oats, 2 cwt. maize meal, 1 cwt. bran, 1 cwt. maize germ cake. The heifers usually calved and were transferred to the dairy herd when they were between two years nine months and three years of age.

System of Costing. Separate accounts were kept for the heifers in the full double-entry set of cost accounts that is made up annually for the Institute farm. It is important to remember that these accounts are kept on a prime cost basis. No attempt is made in them to apportion rent charges or establishment costs, each productive account being expected to yield a surplus of receipts over prime costs to be set against these overhead charges. Each item of cost in the accounts represents a definite service or material supplied for the heifers. Purchased materials and feeding stuffs are charged at cost and home-grown feeding stuffs are charged at round figures, approximating to prices at which they could have been bought or sold, feeding values being considered when necessary. Grazing costs represent an allocation of the total grazing cost for the farm, which includes merely the prime costs of manuring, cultivating, and weeding the fields grazed. The calves are treated as by-products of milk production and no price is put on them at birth.

Number of Heifers Involved. The actual number of heifers passing through the Institute accounts during the four years considered is summarized in the following statement:—

Opening Valuation of heifers	..	..		46
Heifer calves born	..	..	102	
" " sold young	..	..	11	
" " died young	..	..	3	
			—	14
" " reared	..	..		88
Store heifers bought	..	..		18
				— 152
Fat heifers sold (home-bred)	..	..	11	
" " " (bought-in)	..	..	2	
			—	13
Store heifers sold	..	..	2	
" " died	..	..	2	
" " fattened with other stock	..	..	6	
			—	10
Closing Valuation of heifers	..	..		60
				— 83
Heifers reared to maturity	..	..		69

It will be seen that 88 heifer calves were reared past the pail-feeding stage during the period of the accounts and 69

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heifers were reared to maturity. Actually, 55 of the latter heifers were transferred to the dairy herd at the time of calving, and 14 were due to calve in a few months when the closing valuation was taken. It will be seen also that the number of deaths was reasonably small and only two store heifers had to be sold, one being delicate and one being accidentally injured. A relatively large number, namely 19, had to be fattened and most of these were sold within a few months of the time at which they should otherwise have been calving. The six heifers which were transferred for fattening with other stock, however, mostly left the dairy heifers account as rising two-year-olds. Out of the 19 heifers fattened, five home-bred and two bought heifers had to be disposed of for failure in the tuberculin test, three because they were twins with bulls, two did not come into milk well after aborting, one had severe mastitis, and six could not be got in calf although served several times.

Margin on Stock Account. Since the rearing of heifers was a going concern at the beginning and at the end of the 4-year period, the opening and closing valuations have to be taken into account. This necessity introduces complications because the number of heifers on hand at the closing valuation was more than half as many again as the number in the opening valuation. Since the heifers in the valuations obviously could not be valued at cost, the discrepancy in numbers would have a considerable effect on the average costs of the heifers transferred to the herd if it were not possible to make a few reasonably accurate allowances. It is for this reason that the 14 home-bred heifers in the closing valuation which were due to calve in a few months have been included with the heifers transferred to the herd. In the calculations shown later the sum of £1 per head has been added to the recorded costs of keep to allow for the extra costs which would have had to be incurred on these heifers before they calved. The difficulty of the 16 bought heifers, which were on hand at the closing valuation, has been avoided by valuing them at their cost price plus the estimated cost of their keep. All other heifers and calves in the valuations were valued at extremely conservative market prices, ranging from £3 10s. for heifer calves a few months old to £13 for good two-year-olds. The valuation prices were as nearly as possible the same at the beginning and end of the period, and since the numbers valued at these prices have been made roughly the same at

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both valuations, the actual level of the prices has little effect on the costs of the heifers reared.

Although the purchase of the 16 heifers has been prevented from having any serious effect on the rearing costs, the sale and transfer of heifers which did not enter the dairy herd, and the difference between the opening and closing valuations resulted in a considerable income in the dairy heifers accounts. Since this income was produced by the expenditure which also reared the heifers for the herd, it is necessary to set it against the total costs of keep in order to estimate the cost of the heifers reared to maturity. The heifers that were fattened undoubtedly realized less than they had cost to produce. It is, of course, inevitable that out of any number of heifers reared a few will turn out unsuitable for the herd, and any loss incurred in disposing of them is a legitimate charge against the heifers which enter the herd. In most instances fattening is the best method of disposing of the unsuitable heifers with as little loss as possible. Over the 4-year period there was actually a credit balance of £385 4s. 6d. in the Dairy Heifers Stock Account, arrived at as follows:—

DAIRY HEIFERS, STOCK ACCOUNT, 1934-1938							Average Prices per Head		
				£	s.	d.	£	s.	d.
<i>Cr. by Closing Valuation (April 30, 1938) :</i>									
24	store heifers, home-bred	..	..	260	0	0			
20	heifer calves, home-bred	..	..	85	10	0			
16	purchased heifers, at estimated cost	..	..	280	0	0			
							17	10	0
							625	10	0
<i>Cr. by Sales :</i>									
5	fat bullocks	..	..	73	6	3			
13	fat heifers	..	..	236	10	2			
2	store heifers	..	..	12	13	1			
							322	9	6
<i>Cr. by Transfers :</i>									
6	heifers for fattening	..	..				75	0	0
							1,022	19	6
<i>Dr. to Opening Valuation (April 1, 1934) :</i>									
5	bullocks	..	..	37	10	0			
22	store heifers	..	..	223	10	0			
24	heifer calves	..	..	133	15	0			
				394	15	0			
<i>Dr. to Purchases :</i>									
18	store heifers	243	0	0			
							13	10	0
							637	15	0
CREDIT BALANCE							£385	4	6

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Five bullocks that were on hand at the opening valuation and which were sold fat have had to be included in the above stock account because they were grazed and hand-fed along with heifers, so that it was not possible to separate the costs on them from those on heifers.

Cost of Keep. The total prime cost of keeping the heifers for the four years was £1,910 4s. 9d., the details of these costs being set out in the statement below:—

DAIRY HEIFERS, COST OF KEEP, 1934-1938									
			£	s.	d.		£	s.	d.
Wages			282	18	9				
Horse labour			16	10	8				
Tractor and lorry			6	16	6				
			<hr/>				306	5	11
Milk	6,682 gal.		334	2	0				
Separated milk	20,567 gal		171	7	10				
			<hr/>				505	9	10
Bruised oats	238½ cwt		80	12	8				
Ground wheat	32½ "		11	2	10				
Maize meal	123½ "		37	14	9				
Flaked maize	93½ "		31	5	11				
Bran	19½ "		8	8	5				
Linseed cake	121 "		64	17	3				
Maize germ cake	29 "		11	4	4				
White-fish meal	10½ "		8	11	9				
Other meals	12 "		4	14	2				
			<hr/>				258	12	1
Hay	2,538½ "		379	11	6				
Rough hay	550 "		65	0	0				
Straw	844½ "		84	9	0				
			<hr/>				529	0	0
Turnips and mangels, 6,122½ "			155	2	11				
Silage	340 "		17	15	0				
Cabbages, etc.			8	15	0				
			<hr/>				181	12	11
Grazing							92	13	6
Haul, mix and grind concentrates			19	17	9				
Vet. and medicine			16	12	3				
			<hr/>				36	10	0
			<hr/>				£1,910	4	9

Prices. Any consideration of the prime costs depends so much on price levels that it is necessary to give a full account of the prices of the chief items of cost.

The wages paid on the Institute farm are reasonably high for the locality. Ordinary labourers were paid 28s. and stockmen 35s. up to April, 1937, when these rates were raised to 30s. and 36s. In April, 1938, they were raised to 32s. and 37s. 6d., but this was the last month included in this study.

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As only one year of the four was affected by the rises, they have had little effect on the cost of the heifers per head.

Concentrates have been charged in the above accounts at the actual average prices at which each was bought during each financial year, home-grown oats being included at conservative market prices. The prices of other home-produced foods have, however, not been varied during the four years. Whole milk was charged at 1s. per gal., this seeming a reasonable price when the prime cost of the milk was varying roughly between 10d. and 1s. per gal. and the returns for wholesale milk ranged from 1s. 3d. to 1s. 5d. Separated milk was charged throughout at 2d. per gal. Though this is the value generally placed on separated milk, it must be admitted that on the Institute farm it makes separated milk disproportionately cheap compared with whole milk when the relative feeding values are considered. Home-grown hay of good quality was charged at 3s. per cwt., straw at 2s. per cwt., for the quantities estimated to be eaten, and turnips at 10s. per ton. Other home-grown fodder and green foods were charged at prices roughly equivalent to these.

Average Costs. When the allowance of £14, in respect of the extra keep of the 14 heifers which had not actually calved at the time of the closing valuation, is added to the recorded costs of keep, the net cost of rearing the 69 heifers appears to be about £1,540, arrived at as follows:—

	£	s.	d.
Cost of keep	1,910	4	9
Allowance for heifers not calved	14	0	0
	<hr/>		
Credit balance on Stock account	1,924	4	9
	385	4	6
	<hr/>		
	£1,539	0	3

These figures give an average cost for the heifers reared of £22 6s. 1d. per head. It could not be claimed that this average is exact to the final penny, since any inaccuracies in the estimated allowances would alter it, though by a few shillings only. It seems reasonable to conclude that, at the given levels of prices, the cost of rearing heifers on the Institute farm during the four years was about £22 per head.

Increase in Concentrate Prices. The accounts quoted show the costs actually incurred for concentrated feeding stuffs during the four years of the accounting period. During this

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period, however, the prices of concentrates rose considerably, as shown by the following table, which sets out the average prices of the actual quantities of the cakes and meals fed to the cattle concerned during the first and the last of the four years studied :—

	<i>Financial Year</i>	
	1934-35	1937-38
<i>Average costs per cwt. of :</i>	<i>s. d.</i>	<i>s. d.</i>
Oats (bruised)	5 9	8 3
Maize meal	5 8½	7 1½
Flaked maize	6 8	7 9½
Bran	7 3	9 7½
Wheat (ground)	5 7	10 1
Linseed cake	10 6½	11 10½
Maize germ cake	6 9½	9 0½
White-fish meal	16 6	16 8

The effect of these increases on the average costs of the heifers can be clearly seen if the quantities fed are priced first at the prices prevailing in 1934-35 and then at the prices prevailing in 1937-38. The actual cost of the concentrates, as given in the statement of costs of keep above, was £258 12s. 1d., but if the 1934-35 prices had continued it would have been £238, and if the 1937-38 prices had prevailed throughout the four years it would have been about £303. The difference between 1934-35 and 1937-38 prices thus represents an increase in total cost of £65. When averaged over the 69 heifers reared to maturity this increase represents a sum of 18s. 10d. per head. It can hence be considered that at the recent level of feeding-stuff prices, the heifers would be costing almost £1 per head more than they were at the lower prices of 1934-35.

General Considerations. Since the average cost at which it is concluded that heifers were reared on the Institute farm during the particular four years considered, namely £22, is two or three pounds higher than the price at which heifers of roughly similar type could have been purchased in the open market at the same time, it may be as well to point out again that the Institute herd was being graded up and that it was producing a tuberculin-tested grade of milk. It cannot therefore be assumed that the Institute was incurring a loss by rearing heifers, or that it would have been more advantageous for the Institute to have bought in all the heifers required for herd replacements. In fact, the Institute management is well satisfied that the policy of making the herd as

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far as possible self-contained has amply repaid any extra costs by avoiding any heavy losses from tuberculosis.

If the costs on the Institute heifers are to be compared with the usual prices for store heifers, it is only fair to consider how far the costs would be altered if the heifers had been reared in the usual cattle-rearing districts, even supposing that they had been managed and fed as they were at the Institute. First of all, of course, the milk in such districts could only be valued at its price at a creamery, that is, at something around 6*d.* per gal. If this price be assumed for whole milk in the above accounts, the average prime cost of the heifers reared to maturity would be reduced by about 48*s.* per head. Most farmers in such districts employ little or no labour, and most of the labour charge, amounting to something like £4 per head at the Institute, would be avoided, the farmer earning it for himself, so to speak. In this context the sale of store cattle becomes also one of the farmer's ways of realizing cash for his home-grown crops, and practically the only cash outgoings he incurs in rearing the cattle are for concentrates and for expenses entailed in growing the crops. It can thus be seen that, apart from any economies that the ordinary farmer might make as compared with the Institute, such a farmer would still have a considerable cash margin of returns over expenses in the rearing and sale of calving heifers at a price around £20. This article provides no evidence as to whether this cash margin would be sufficiently large to go towards meeting the rent or annuities and other overheads on the farm and also to provide the farmer with a suitable remuneration for himself.

THE FLYING BENT

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Description. The flying bent (*Molinia coerulea*), sometimes called purple-melick grass or blow-grass, is described by Armstrong¹ as a perennial which forms conspicuous tufts, and has tough, cord-like roots. The sheaths are smooth and split, and the almost ribless leaf blades are rolled in the shoot, narrowing below and tapering above to a fine point. The ligule is either short or represented only by a tuft of hairs, a characteristic by which the plant can be easily recognized. It flowers about July, and the culms are usually 2-3 ft. high, but height appears to vary with situation. Spikelets are numerous, small, erect and of a green or more frequently purplish colour.

Molinia seems to flourish under widely varying conditions of soil and topography, but is commonly found where there is a high degree of acidity, as on upland peats, and/or in situations which are definitely wet but not waterlogged. Jefferies² has stated that "We find it on open plateaux and in sheltered valleys, under the open sky and in the shade of woods, on steep slopes and on flats, around springs, on stream banks and in flushes." The same writer states that he met with it on acid peaty soil at high elevations and in low-lying fens which were calcareous or neutral. Stapledon and Hanley³ find that *Molinia* is prone to occupy the more or less well drained flush sides of mountain streams, or hill sides with slight or moderate gradient and some drainage. It may dominate large areas of hill land, alone or in association with *Nardus* or heath rush. In the wetter places, *Molinia* moor merges into deer-hair moor, and into *Nardus* moor on the drier and shallower soils. It may be of interest to record that an attempt to establish *Molinia* in a fertile and well drained loam at Cockle Park has so far met with little success.

Molinia has a short growing season which commences rather late—usually at the end of April or the beginning of May in Northumberland. From this time until the flowering stage is reached (in late July or early August) a luxuriance of leafy material is produced. After seeding, the leaves wither, and

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being naturally thin and light, break off at the root. During winter they are often laid in the direction of the prevailing wind or, more frequently, are carried away. It is because of this latter characteristic that the plant is known as the flying bent.

According to Preston,⁴ *Molinia* is eaten by sheep, but cattle generally refuse it, or crop it only in early spring or when compelled by hunger. Most hill farmers, however, believe that it provides useful keep for both cattle and sheep, and this view is held by Wallace,⁵ who has stated that both classes of stock do well and fatten on the young growth; he adds that in some places they consume little else for a month or more, and continue to eat it all summer, though to a lesser extent during the later months. *Molinia* cannot be considered of much value for winter keep, and is in this respect quite definitely inferior to such plants as *Eriophorum vaginatum* and *Juncus squarrosus*.

The only management ever applied to *Molinia* moors is burning in spring, and the frequency with which this operation should be carried out has been the subject of controversy. Some authorities incline towards frequent burning, e.g., at 2-year intervals, others favour a much longer period. The latter school holds that with short intervals between burning the plant tends to die out. In any event, early spring burning has the immediate effect of producing a flush of fresh young growth, which is well liked and hard grazed by sheep; the wisdom of allowing cattle to graze freely on it appears to be doubtful.⁶

Composition and Feeding Value. For the purpose of obtaining some reliable information on the composition and feeding value of *Molinia* throughout the growing season, samples were taken at approximately monthly intervals during the spring, summer and autumn of 1938 from the Smale forest in the valley of the North Tyne. As already indicated,⁷ the ground covering of these plantings consists largely of *Molinia*. Samples obtained during April and May consisted of erect, green shoots, sufficiently tender to be drawn easily by hand. At later dates, when the grass had become harder and tougher, it was cut close to the ground by means of heavy scissors. The treatment to which samples were subjected on reaching the laboratory has been described elsewhere.⁸

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The analytical results obtained are tabulated below.

TABLE 1.—PERCENTAGE OF DRY MATTER

Sampling Date (1938) :	April 26	May 27	June 27	Aug. 10	Sept. 8	Oct. 13
*Crude protein	19.26	17.93	14.84	14.40	10.67	7.58
Ether extract	1.87	2.01	1.75	2.27	1.64	1.94
N-free extractives ..	47.87	46.90	41.90	48.13	51.37	52.22
Fibre	24.67	25.95	32.06	31.09	32.37	34.32
†Ash	6.33	7.21	9.45	4.11	3.95	3.94
*Including :						
True protein	16.46	17.04	12.92	14.06	8.50	5.54
True protein/crude protein ratio ..	0.85	0.95	0.87	0.98	0.80	0.73
†Including :						
Phosphoric acid (P ₂ O ₅)	1.041	0.747	0.626	0.472	0.354	0.200
Lime CaO	0.173	0.179	0.166	0.275	0.320	0.230
Silica	1.38	2.16	1.79	0.80	1.21	2.92
Percentage digestibility of crude protein (Wedemeyer) ..	79.12	66.31	62.54	54.51	48.08	58.44

It will be seen that the young growth, sampled on April 26, has exceptionally high feeding value. Crude protein and phosphoric acid contents are such as one might expect to find in grass from the best type of fattening pasture, and the fibre is not unduly high. The digestibility of the crude protein is very satisfactory, no less than 79 per cent. of this constituent being in the digestible form.

Although there is a diminution in protein and phosphoric acid during May, these two constituents nevertheless remain relatively very high, and only a slight increase in fibre is evidenced. During the period May 27-June 27, the quality of the grass, as indicated by analysis, suffers sharp deterioration, but, apart from a fall in the proportion of phosphoric acid present, there is little further change between the latter date and August 10. The true/crude protein ratio is at a maximum (0.98) at this time, and may be one factor contributing to the lower digestibility of the crude protein in the August sample.

After August, the feeding value of *Molinia* appears to decline markedly; phosphoric acid content falls in sympathy with crude protein, so that the proportion of the first of these constituents in the October sample is only 20 per cent. of that obtained in the youngest growth, while fibre increases. The

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digestibility of the crude protein is particularly low during September, but improves in the succeeding month. This increase may be attributed to a rise in the proportion of non-protein nitrogen present if, as is generally assumed, the latter is soluble in pepsin-hydrochloric acid. This tendency for the ratio of true to crude protein to fall in autumn and winter grass has already been noted by Thomas and Boyns,⁹ who attribute it to evacuation from the foliage, and regard it as an indication that hydrolysis is playing a major part in the process of metabolism at this time of the year.

The only previous analysis of *Molinia* made in this country appears to be that of Kinch¹⁰ who, as long ago as 1883, showed that the younger growth is particularly rich in nitrogen. The limitations of ordinary analytical methods as a means of assessing the nutritive value of fodders are well known, and are fully appreciated by the writers, but it does seem that the results obtained in the course of this investigation not only bear out the findings of Kinch, but suggest that *Molinia* provides valuable feed during a period of at least three months. During this time the grass, but for its marked poverty in lime, compares favourably on the basis of analysis with the most reputable members of the natural order *Gramineae*.

Conservation as Hay and Ensilage. There seems little reason to doubt that if better grazing control were practicable, *Molinia* would have a longer period of utility than is now possible. As it is, the plant usually grows right out of hand, a very large proportion of the youngest and most nutritious growth is wasted, and large residues of unutilized material remain to choke open drains and ditches and to lend colour to a reputation for worthlessness which is not easily justified.

Even if better and more complete utilization by grazing is impracticable—and a discussion of this aspect is not within the scope of the present article—it should be borne in mind that the hill farmer has at his disposal two methods whereby he can conserve the produce of his *Molinia* pastures. The first of these involves conversion into hay, and it is a fact that a good deal of *Molinia* hay is made. If cut before seeding begins, a heavy yield of high quality material may be obtained. Haymaking can be carried out rapidly in favourable weather, as the mature leaf dries very quickly. Linton¹ has stated that *Molinia* hay is unsurpassed for feeding to hill sheep and to cattle, and that the aftermath is always

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keenly grazed. Attention has recently been drawn by Watson¹¹ to the advantage of ensiling the unconsumed produce of upland grazings, with the addition of appropriate minerals. *Molinia* would appear to be an excellent subject for such treatment, and when reinforced by the addition of a suitable calcium salt should produce a silage of high feeding value. In late upland districts of relatively high rainfall, successful haymaking is dependent to too great an extent on favourable weather conditions; on the other hand, ensilage is largely independent of weather conditions, and can be carried out during slack periods when the work need not interfere materially with other important farming operations.

Such an authority as Stapledon¹² has admitted, by implication, that *Molinia* is of great potential value. Referring to the rapid growth which occurs on *Molinia* moors, he stated: "I know of no other example of such complete waste of valuable material in the whole gamut of our agricultural practices." As the methods of hill-land improvement demonstrated in Wales are unlikely, for economic reasons, to be adopted on any considerable scale within a reasonable period of time, it appears to the writers that present efforts should be directed towards the utilization of such grasses as *Molinia* which are now on the ground, and which are by no means so worthless as is popularly supposed.

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THE RABBIT PROBLEM

A. V. CAMPBELL

That we should say "rabbits" on the first day of the month, either to ensure some degree of prosperity or possibly to ward off the evil eye, is a custom the origin of which is veiled in mystery. No less mysterious is the choice of the word used, unless it be that damnation to the arch enemy of husbandry is the best of the innocuous oaths and that a constant reminder of his presence is desirable lest there should be any slackening of vigilance or suggestion of quarter.

How to deal with the rabbit presents those interested in the countryside with one of the most difficult of the "minor" problems with which they are faced. Opinions may no doubt differ as to whether the use of the word "minor" is not an understatement of the position. Not only are rabbits responsible for damage to crops but, through their promiscuous plundering, are apt to be the cause of frayed tempers and may even come near to destroying that social harmony which all those who live on and by the land desire.

It is true that the Ground Game Act sets certain limits to ownership; nevertheless, rabbits are often a bone of contention between neighbours, landowners and tenants.

While legislation to enforce at least partial control would appear by common consent to be desirable, it must be recorded that, after numerous attempts, no Bill laid before Parliament has succeeded in reaching the Statute Book and we continue to make the best of a bad job.

Recently a Select Committee of the House of Lords has examined the question anew.* Their report provides much interesting reading, and should be studied by all interested in the problem, for in it are reviewed the legal, social, economic and humanitarian phases which require satisfaction.

The whole problem of the rabbit, one might say, arises out of the fact that, although theoretically vermin, it may at times and on certain classes of land make contributions to income. Because the rabbit has a market value, man is blind to the fact that it is essentially vermin and, therefore, ought to be

* Report of the House of Lords Select Committee. Agriculture (Damage by Rabbits), 1937. H.M. Stationery Office, price 4s. 6d. (by post 4s. 8d.).

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suppressed. He expects it to be worth at least the cost of control, or even more, and complains when circumstances put its value below this figure.

He is faced with the alternatives of attempting extinction at a probably heavy cost or of restricting the breeding stock each year to avoid serious losses to crops and yet to leave sufficient to give him a worth-while seasonal trade in carcasses together with some amusement.

The legislative approach is rendered difficult by reason of the fact that the method of control desired must, while visualizing the pest phase, also take into account the economic relationship of the rabbit to the agriculture of some of the areas in which it is found. Indeed, there are areas in the country in which £40 per 1,000 couple is paid for the privilege of taking them. Nevertheless, in all areas, whatever the density of the infestation, the rabbit must be regarded as a competitive crop and, therefore, considered as a source of profit or loss according to the nature and productivity of the land which it inhabits, the cost of catching, collecting, and marketing, and the price received.

It will be noted from the evidence presented to the House of Lords Committee that one of the first questions which received consideration was whether the problem could or should be attacked from the standpoint of extermination or control. Although many would doubtless desire to see the rabbit eradicated, the opinion held by most people is that the evil is too deep-rooted to allow of an offensive conducted towards this end. Despite the desirability of eradication, there appears to exist the probability that we may be forced, under a rigid system of control comparable with that exercised over other live stock, to allow the rabbit to make contributions to our food supply and provide raw material for the furrier or hatter until such time as a better use can be made of some of the land which it inhabits.

With the merits of extermination or control, or the legal aspect of the rabbit problem, these notes are not primarily concerned. They are prompted by a desire to examine certain economic aspects which form part of the general problem. While one of these has been put forward as offering a possible line of approach to supplement or even take the place of direct legislative action, the other, which arises out of it, concerns the possibility of assisting direct legislation by making possible a higher salvage value through the elimination of

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certain wastages that occur in marketing, and by so doing maintain an orderly flow of rabbits from the farm to the consumer without enhancing the price of rabbit meat.

It has been suggested in some quarters that if the price of the rabbit could be advanced until the value received was adequate recompense for the cost of catching, the problem would solve itself. The method suggested is that imports should be prohibited.

Examination of this aspect at once reveals an interesting paradox, namely, that despite the consumers' alleged preference for fresh English rabbits over imported Australian, the latter over long periods are said to command on the average a fractionally higher price.

The reason is not hard to find, for Australians imported in frozen condition are only released on to the market when the shortage of English rabbits warrants their appearance. Further, the cold-stored rabbit is mainly utilized on the large central wholesale markets and but seldom finds its way into provincial towns, which appear to be well supplied with local catches in fresh condition. The quantity of home-killed rabbits consumed annually in this country is not less than 36 million, a figure which has been computed from the number of home-killed skins available for export, together with those known to have been used in the hatters' fur industry. Taking the agricultural land of Great Britain at 30-million acres, this represents an average catch of 1.2 rabbits per acre. The figure is a minimum, since not all skins from rabbits eaten at home find their way to the skin dealer. In all probability the home catch approaches a couple per acre, or 60-million rabbits each year, while the number of imported frozen rabbits retained during recent years has been as follows:—

GROSS IMPORTS, RE-EXPORTS, AND NET IMPORTS OF FROZEN RABBITS
RETAINED FOR HOME CONSUMPTION

		<i>Imports</i>	<i>Re-exports</i>	<i>Retained for Home Consumption</i>	
		<i>cwt.</i>	<i>cwt.</i>	<i>cwt.</i>	<i>No.</i>
1932 ..	..	546,238	23,354	522,884	20,915,360
1933 ..	..	470,321	21,885	440,436	17,937,440
1934 ..	..	508,421	12,330	496,082	19,843,280
1935	245,946	10,915	235,031	9,401,240
1936	162,808	8,499	154,309	6,172,360
1937	123,167	6,516	113,651	4,546,040

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The reason for the low price of home-killed rabbits to catchers cannot, therefore, entirely be attributed to competition from imported supplies. Attempts at pest control by the raising of the price of rabbit meat do not appear to offer great possibilities on other grounds. On the one hand, if the price increased, the incentive to preserve would become apparent and thus the object of control might be defeated, while, on the other hand, any hardening of rabbit-meat price by artificial means would result in a falling off of demand, for it must be recognized that the rabbit is the poor man's "chicken," and the prices generally ruling are related to the prices for the alternative meat choices available. A 2½-lb. rabbit in the skin selling retail at 1s. yields meat at a value of slightly over 6d. per lb., and it would appear impossible to push the figure higher without losing custom through incurring competition with other meats.

Thus we appear to have arrived at an impasse. It is not generally recognized, however, that the story does not end with the disposal of the meat portion. There still remains the question of the skin, for the rabbit has both a meat and pelt value. Advantage of the pelt value can seldom be taken by trappers, by reason of the fact that under present conditions of disposal of fresh rabbits the value of the pelt barely arises until the meat is disposed of. Prices to catchers are, therefore, mainly determined by meat values unless the prices of skins are extremely high.

The average householder has neither use for skins nor generally the ability to remove them; mutual satisfaction is therefore gained through the practice of the retention of skins by the retailer in return for the service of skinning before delivery.

That the practice is necessary is not disputed; nevertheless, an examination of the fur trade suggests that the method is wasteful and a contributory cause to low farm prices, since the fur so obtained is only useful for what is known as the cutting trade.

The point to be made can be better appreciated if brief reference is made to the purposes for which skins are required. Rabbit skins have two main uses and are absorbed by the furrier or cutter according to their qualities. These two trades have nothing in common except the fact that their starting points are rabbit skins. The furrier is concerned with the fashioning of gloves, trimmings, coats, or linings. The

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skins demanded must be in good condition and must have been removed from carcasses preferably within twenty-four hours of killing.

The cutter, on the other hand, treats the pelts with certain chemicals and then shaves the hair and fur from them by machinery, after which the cleaned fur is sold to hatters. It is not generally known that the fur from two or three rabbits is required to make the average felt hat. The yield of fur is roughly 7 lb. per 120 wild rabbits. The prices paid by furriers are consistently higher than those paid by cutters; only in times of high prices and acute shortage do skins taken from rabbits exposed in shops in the skin find their way into this higher-priced furriers' market. In 1934, some 27-million furriers' skins were imported. Although the demand for dressed rabbit skins in the United Kingdom is not high, a large market exists. The requirements of America alone are over 100 million skins annually.

When it is realized that the rabbit has a dual value and that accessibility to the higher-priced pelt market is, under the present system of marketing, denied to the catcher, one is tempted to inquire whether a fundamental change in distributive procedure, which has as its objective the avoidance of glutted markets by the orderly release of carcasses, and the enhancing of pelt values, might not be advantageous on several counts.

Not only could large fluctuations in the price of rabbit meat be avoided, but wastages from decomposition and those incidental to the pelt trade be eliminated. One might hope that the results would stimulate orderly catching and thus make some contribution to the problem of control, whether implemented by legislation or not. Further, owing to the compactness with which it is possible to crate the edible portion of the carcass, the storage accommodation required in time of emergency probably compares favourably per pound of meat with that required by any comparable commodity.

The realization of this objective can only be brought about by a fundamental change in distributive procedure, by the organization of collecting, skinning, refrigerating and distributing points in the more densely-infested areas.

Although the approach to the fundamental problem may not lie in the direction of price increases, it is obviously desirable to make the best of a bad bargain and not blind ourselves to the possibility of obtaining a higher salvage value.

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In this lies a marketing problem which demands co-operation between many interests. Not only must supplies be available, but the animals captured must be correctly killed and gutted. A skinning technique and a knowledge of skin preservation and dressing is also requisite. Cooling and refrigeration to preserve the colour must also be understood, while a connexion with distributors and the public must be sought.

In addition to technical knowledge of the several branches of the contributing interests, faith in the possibilities, the good will of those who look on the rabbit for good or evil, and a considerable amount of capital are necessary.

An attempt to contribute to the solution of the problem by the stabilizing of rabbit prices at remunerative levels to catchers, by the organization of the disposal of the meat in the most advantageous manner, and the avoidance of unnecessary waste incurred through the loss of good skins and the cost of reassembling skins held by innumerable retailers, is being made in one or two densely-infested areas. Skinning and refrigeration depôts have already been opened in Norfolk and on the fringe of the distressed area in South Wales. At each centre the system of working is the same. The promoters, who welcome the support of land owners in participating in the experiment, purchase or contract with farmers, land owners or catchers for supplies.

The writer of these notes recently visited a dépôt in Norfolk, where the fullest information concerning technical and other points was given without reserve.

These fall conveniently into three groups: predelivery, operations at the collecting centre, marketing.

PREDelivery: *Catching.* It must be at once obvious that if the best use is to be made both of carcasses and skins, rabbits must be taken otherwise than by shooting, although shot rabbits can be handled. Against shooting there are two objections: on the one hand the pelt is too badly punctured to be of value except to the "cutting" trade, while the presence of shot marks which become suffused with blood detract considerably from the appearance of the carcass when exposed for sale.

Gutting must be carefully carried out, as small an incision as possible being made with a sharp knife well forward in the belly, and under no circumstances carried down to the vent, since the skin at this point between the hind legs must remain

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intact to allow for stretching and subsequent flaying. Since decomposition is liable to set in the moment the rabbit is dead, gutting should be carried out as soon as possible and the catch delivered to the skinning depôt within 24 hours.

OPERATIONS AT THE COLLECTING CENTRE: *Skinning.* On arrival at the depôt, skins are removed by a special technique which allows the best use to be made of them. After removal, they are hung on suitable stretchers which retain them in a condition in which the trade desire to handle them, whether for dressing or cutting.

When stretched, the adhering body fat is removed. They are then dried on racks in a well-ventilated room through which warm air is passed, after which they are assorted into 12 grades according to their quality and packed for removal to the furrier.

Grading Skins. A preliminary grading can, when desired, take place at the time of skinning, and in fact the skins, when doubt exists, give an indication of the quality of the rabbit.

Grades of skin are determined by age, size and season. As an indication of age they provide useful information concerning the quality of the meat portion of the carcass. The reverse of the skins from young animals is blue when removed. As the rabbit gets older a blue and white mottling stage is passed through before they eventually become white or, as it is termed in the trade, "clear pelted."

Carcass. After skinning, the carcasses are washed in running water, trimmed, cleaned and examined for any sign of disease, after which they are dried, graded and eventually packed in non-returnable crates lined with greaseproof paper to a constant number of 24 or 26 according to size and to a weight of 50-56 lb. per crate. Inside the top lid is placed a sheet of transparent paper that acts as an overlay to protect the rabbits from dust during display in shops.

MARKETING. The crates are wired down and cooled for six hours, after which they are held under such conditions of cold as will ensure safe transit until exposed for sale in shops.

In order to enhance the appearance of the carcass and also give an indication of quality and origin, the affixing of a disc label of a type now commonly seen is under consideration. This has been deemed necessary to enable the public to distinguish these carcasses from the imported frozen ones.

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Given a brisk demand, no necessity appears to occur for holding English rabbits except in a safe travelling condition; the cold store is therefore only resorted to in order to accomplish this and also ensure an orderly release and the avoidance of gluts. The condition of rabbits so exposed would therefore appear to be comparable to other meats held over from one market to another without jeopardizing the right to the epithet of fresh.

One final point remains; the venture can only be successful provided the consumer is prepared to accept rabbit meat presented ex skin instead of in the more familiar fashion.

Indeed, it is possible that failure to contribute to the ultimate objective which is the mitigation of what is a national menace may result from the attitude of the consumer. Although the South Wales Depôt which has recently been opened is now dealing with five to six thousand rabbits a day, sales are reported to be slow and difficulty is being found in clearing catches at prices now current for rabbits exposed for sale in the skin. The reason for this is not altogether clear unless it be that the condition of presentation is unfamiliar. It is hoped that in the interests of this private attempt at marketing reorganization the prejudice against the acceptance of rabbits ex skin and marked as being of home origin will be overcome, since if the method adopted was universally applied to the English catch it might conceivably assist the farmer in obtaining a better salvage value for an animal which at best must be regarded as ranking high in the list of agricultural nuisances.

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Ploughing Up of Poor or Worn-out Permanent Grass Land

In connexion with the scheme for ploughing up grass land announced in the House of Commons by the Minister on May 3, and outlined on p. 209 of this issue, the following notes, based on the experience of ploughing up during the War and on more recent work on the rejuvenation of grass land, may be of assistance to farmers who contemplate ploughing up and re-seeding under this scheme.

Heavy Loams and Clay Soils. In the *North*, particularly in the industrial regions, there are large areas of poor, worn-out grass land of a heavy nature in urgent need of improvement. The method which seems to offer the greatest prospect of success is that of ploughing up the old turf in summer and sowing down immediately. The old turf must be completely buried by a flat furrow, in order the better to smother the herbage and facilitate consolidation. Immediately after ploughing, and before the soil "sets," disc harrows should be used first along the furrows, then at an angle, or across the furrows, the object being to work up sufficient fine tilth without bringing the old turf to the surface. After discing, the land should be levelled by ordinary light harrows, or spiked chain harrows, rolled with a Cambridge roller so that the seeds will fall in the shallow depressions left by this implement and covered over by harrowing. A smooth roller completes operations. A nurse crop is not essential and the indications are that it is undesirable.

Heavy land in the North ploughed as late as September or October should generally be allowed to lie through the winter in a well set-up, unbroken furrow, and go to a suitable nurse crop

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in the spring of 1940. By that time the furrows will have had time to weather and settle down and the seed of the nurse crop can, if necessary, be broadcast. Adequate harrowing and rolling must, however, be given to secure the requisite "tightness."

In the *Midlands* and *South of England* much inferior grass land exists on heavy loams and clays. The turf on land of this description is usually full of weeds, especially of bent (*Agrostis*) which unless killed would prove very troublesome in arable land and would be likely sooner or later to dominate a new pasture. It is, therefore, necessary to sever the turf from the sub-soil and dry it on the surface. At latest, ploughing or cultivation needs to be taken in hand immediately after the hay harvest. The sun and rain will mellow the clods or furrows and there will be time to work them into a seedbed before the autumn. No implement can search out and mellow a raw clay soil so well as the summer sun. In such circumstances, wheat or beans would generally be selected as the most suitable crop for autumn sowing, and under the former a new seeds mixture could appropriately be sown in spring.

When heavy loams or clays covered by inferior herbage cannot be tackled until September or October the best plan, as a rule, will probably be to invert the furrow slice and leave the land uncropped till spring. No attempt should be made to reduce the soil to a fine or firm tilth if it is to lie uncropped over the winter. On late-broken clays spring oats may do fairly well in the Midlands and make a suitable "nurse" for seeds, but in the South, beans in February or peas in March would be more suitable. Another useful crop for the spring of 1940, particularly in the South, would be a mixture of peas and oats. This may be made into hay or silage if sown before the end of May, or harvested as grain for stock-feeding if sown earlier. As soon as the ground is clear of crop it may be disc-harrowed and prepared for sowing with a seeds mixture any time when the soil is moist enough up to mid-September. In such circumstances further ploughing is unnecessary, likewise a nurse crop. Indeed, for the South of England, surface stubble cultivation, including pea stubble, is probably the most satisfactory way to establish a full plant of seeds. Beans are usually harvested too late to permit of stubble seeding. It would probably be necessary with this crop to follow with wheat and under-sow to grass the following spring.

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Medium and Light Soils. There is a very large area of land of this description in England and Wales. Some of it may be old grass with a thick matted turf as, for example, in the industrial areas, or thin-skinned pastures which have been allowed to lie for many years in grass, as on the chalk.

Medium and light soils may, in suitable circumstances, be immediately re-sown to grass, with or without a nurse crop such as rape or a fodder mixture for cutting green. In regions of moderate or high rainfall immediate re-seeding is one of the best ways of establishing an improved sward. In dry districts grass seeding on a disced stubble, e.g., peas and oats, vetches or linseed, after harvest gives equally good results, and in suitable instances, subject to the approval of the Agricultural Department* concerned, such soils may be sown with a catch crop, e.g., mustard, vetches, a mixture of peas and oats† for cutting green, linseed, rape, kale, turnips, buck-wheat and mixtures of rye grasses and clovers (all, incidentally, crops not susceptible to damage by wireworm).

Where it is not possible to plough medium and light soils until October, the land may be allowed to lie in the furrow over the winter and be sown with oats or other suitable crop in the spring of 1940. To minimize risk of damage by frit fly, oats should be sown before mid-March. Alternatively, wheat or winter oats may be sown in autumn. On the lighter classes of soil there is usually some risk of damage by wireworm when a cereal is taken as the first crop after old grass. Thorough disintegration and consolidation of the seedbed and an extra allowance of seed are the best safeguards. Commonly a second cereal crop suffers more damage than the first crop. Where appreciable wireworm infestation is to be feared, relatively safe crops are: beans, peas, vetches, or mixtures of legumes and a cereal, linseed, mangolds, sugar-beet, kale, rape, mustard.

Essential Points in Cultivation. Whatever methods of cultivation are adopted other than summer fallowing, it is above all necessary to get the turf well buried. For this kind of work the shorter the herbage the better. In many parts of England, this year, most of the roughage, has been well

* The Ministry of Agriculture and Fisheries, the Department of Agriculture for Scotland, and the Ministry of Agriculture, Northern Ireland.

† No additional subsidy will be payable in respect of a cereal included in such mixture.

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cleared off as a result of drought last summer and consequent hard grazing during the winter. So long, therefore, as the ground is not too hard, less difficulty than usual should attend early summer ploughing and less trouble should occur with soil pests. As a rule, the procedure is fairly simple: bury all vegetation by careful ploughing, using a disc coulter and, where the turf is not too matted, a skim attachment, turn a flat furrow, consolidate immediately and till on the top by disc harrows, then follow with levelling harrows, Cambridge roller, seeding, harrowing and flat rolling. With all land ploughed out of grass in summer, the efforts of the farmer must be concentrated on getting it sufficiently solid before seeding, and the thicker the turf the more necessary the flat ploughing, the discing and the rolling. In the drier districts, especially, it is important that the seedbed should be so compacted that there is no break in passing into the sub-soil. On the more friable soils it may be desirable to roll before discing. With stiffer soils the discs may fail to "bite" if the surface has dried and been made too tight by prior rolling.

Manures. Poor grass land is generally short of phosphates. Many soils were almost exhausted of available phosphates before they "tumbled" down and many others are deficient in phosphates as the condition of the existing vegetation shows. In many places there is also a marked shortage of lime in the soil, notably in industrial districts, on the Coal Measures, Millstone Grit and certain sandy soils. A return to the plough affords the best means of restoring these essential requirements. Both phosphates and lime act best when worked into the seedbed, or otherwise thoroughly incorporated in the soil. In some instances potash also will be needed and on the poorer soils a light dressing of nitrogen will have a marked effect in promoting the early establishment of a luxuriant sward.

Farmers who intend to avail themselves of this scheme are reminded of the facilities under the Land Fertility Scheme for assistance in the provision of lime and basic slag.

Technical Advice. The success of the scheme will naturally depend greatly on skilful workmanship and judgment in the choice of land for breaking. Facilities for technical advice are available through the County Agricultural Organizer, whose address is normally the Agricultural Education Offices of the county town. Farmers are strongly advised to consult

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him as to the suitability of their land for ploughing up, the most suitable cultivations for attaining the end in view, as to suitable dressings of lime and fertilizers and appropriate seeds mixtures.*

Grass Land Unsuitable for Breaking. The scheme is intended to effect a permanent and substantial improvement in the fertility of grass land of potential value for arable cropping: it is not intended to encourage the breaking up of very heavy or water-logged grass land carrying poor grass. Cold, wet soils are usually very deficient in phosphates, and not only drainage but expensive tillage and liberal manuring would be needed. Land of this description would probably not, even in an emergency, be broken up until the surface had been enriched by white clover and other legumes which usually follow a generous dressing of basic slag.

Very light sandy soils are another category which should not, save in exceptional circumstances, come under the plough. Such soils are easy to till but they require large quantities of animal or other organic manure, artificial fertilizers and lime, and cannot, as a rule, be made to grow the ordinary farm crops economically.

At the other end of the scale are the rich pastures. It is axiomatic that if there is to be good arable there must first be good grass, but, under present conditions, land already carrying good grass should not be broken up. Such grass land has a special value; not only are its feeding properties high, but it withstands dry weather when other pastures become bare and it is especially useful for out-wintering.

Notice to Applicants. In order to qualify for grants, farmers will be required to satisfy the appropriate Agricultural Department that the land ploughed up:—

- (i) had been under grass for at least seven years;
- (ii) has been, or is being, brought into a state of cleanliness and fertility by approved methods such as by fallowing, by direct re-seeding or, subject to the approval of the Agricultural Department concerned, by taking a suitable catch crop during the present year; for example, mustard, vetches, rape, kale, turnips, buckwheat, and mixtures of rye grasses and clovers;
- (iii) is land that will be likely to benefit by such cultivations with a view to re-seeding or re-introduction into a suitable rotation, and would be likely, if the need were to arise, to produce satisfactory arable crops for harvesting in 1940.

* Information on suitable seeds mixtures is also obtainable from the Ministry's Advisory Leaflet No. 123.

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Such ploughing is intended to be over and above the normal rotation ploughing of the farm. Applicants for grants are also warned that their land may be inspected at any time either before or after ploughing has taken place by an Officer of the Department and payment of grant will be dependent upon compliance with these conditions.

Farmers are also reminded that in many cases permanent grass land cannot be ploughed up without the consent of the landowner concerned and, as stated in the House of Commons, it is not intended to seek to set aside any provisions in farm agreements which require the prior consent of the landowner before such land is broken up.

Occupiers should furthermore bear in mind that they may have to crop the land, even if it has been re-seeded this summer, in the event of a national emergency.

Quick-Return Compost Making

The following note has been contributed by Mr. L. F. Easterbrook :

Whenever two or three agriculturists talk together for long in these days the conversation usually turns to the fertility of the soil, and from that to the question of organic fertilizers. The composting methods of the late Dr. Rudolf Steiner and Sir Albert Howard, known only to a select few five years ago, are becoming household words in many a farmer's home, even if he doesn't apply them.

For over two years, however, we have been experimenting in West Sussex with a third method, developed from Steiner principles by Miss Maye Bruce, of Sapperton, Gloucestershire. Publication of the details of this method for the first time, in a national newspaper last March, aroused so much interest that Miss Bruce had over 1,100 requests in four weeks for further information. Our own experience has given such remarkable results both in the speed and simplicity of making the compost heap that it may not be out of place to make this method more widely known, especially since it would be of particular value if ever this country became involved in war.

The method is as follows. A foundation of rubble is prepared for drainage purposes, say 3 in. deep. Half an inch of charcoal is spread over the rubble, for charcoal has great absorptive properties. A wall, to keep in the heat, is then built round it. Old railway sleepers are the best for

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this purpose. A dozen of them, three to each side of a hollow square and placed side upon side, makes a bin of convenient size, 9 ft. square and about 4 ft. high. Stout planks may be used, or brick or stone walls if ventilation is given, but never corrugated iron. For convenience, this bin should then be subdivided into four divisions with 1 in. wood.

Now the heap can be built. All garden refuse may be thrown in except hard wood. But weeds, bracken or hedge trimmings may all be used and stinging nettles, especially if wetted and crushed, are of great value. All seeding weeds should be placed in the centre of the heap, where the heat will destroy their germinating power. Woody material may be burnt and the fresh ashes added. Autumn leaves, however, retard decomposition. At approximately 12 in. sprinkle *unslaked* lime. At 24 in. it is helpful to add a layer of any animal manure except pig. At 36 in. give a second sprinkling of lime. Build up to about 3 ft. 6 in., treading each layer firmly, then cover with 6 in. of soil. It should be protected from drenching rains and a split hop pocket (price 1s. at any brewery) makes an excellent tent if held up by a ridge pole so that the air may circulate under it. An additional sack laid flat on the heap for the first month helps to keep in the heat.

Left to itself, this heap would revert to soil. The process can be hastened, however, by inserting six herbal essences, that also balance the compost. These essences are made from nettle, yarrow, camomile, valerian, dandelion and oakbark, which possess between them soda, lime, calcium, iron, potash, potassium, sulphur and phosphorus. Pure run honey is also added. Miss Bruce has found by experiment that these essences, including the honey, give far better results in a solution of 1 in 10,000 than when made at 1 in 10, or 1 in 100 and so on. This is an interesting illustration of the homoeopathic theory of "the power of the infinitely little." Miss Bruce will tell anyone how to make them, or, to save trouble, they may be obtained from her at a nominal charge to cover packing and postage. There is no secret, no patent and no proprietary right in connexion with this method.

After this the compost heap needs no attention. No turning whatever is required and the refuse becomes rich, friable soil, very sweet smelling, in about 12 weeks in winter and 6 weeks in summer. The solutions can be mixed together and added in one operation. Miss Bruce has been experimenting in

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further simplification for use on farms. With a light piece of boarding or thatched hurdles round the sides, the top ridged and covered by a hop pocket, November bracken, nettles, thistles and coarse grass were turned to soil by early January—in about 7 weeks in a heap built in the open in a cold wet year.

We have used the first of these two methods, the one with sleepers, for over two years. So far it has done everything claimed for it. We have never had vegetables of such flavour, our flowers have never lasted for so long. Some of our soil is on the sticky side, and this spring was not a particularly dry one, but where the compost had been applied we could get on to the land and the soil would “fall through the fork” about three weeks earlier than usual. Since starting to use this compost, we have stopped all spraying for plant diseases, except green fly on the roses, but to date no disease has worried us. In dry periods it is noticeable how the soil retains its moisture where the compost has been applied. This year's lawn mowings have just been put back as sweet-smelling soil exactly 30 days after the mower cut them. When we tried making one heap of lawn mowings by this method, but leaving out the herbal essences, they took longer to rot down and were an unsavoury, slimy mess. The temperature in the middle of a bin of herbaceous waste was 178°F. last November; this spring's lawn mowings gave a temperature of 190°F.

We have noted that vegetables grown with the compost seem rather backward at first in their top growth, then come away with a rush. This is due, we think, to concentration by the plant on its root growth in the earlier stages. The belief is reinforced by the behaviour of our potatoes grown with the compost. We have had to plant the rows 30 in. apart instead of 24 in. because the root growth was so extensive that we could not get a fork between the rows without damage to the tubers.

Town Waste as a Source of Humus

In a paper read at a meeting of the Institution of Sanitary Engineers on May 5, Sir Albert Howard emphasized the immense loss of potential humus incurred in modern methods of urban waste disposal. He contrasted the agriculture of the East, particularly of China, where by the proper conservation and use of animal and vegetable waste a population of some 2,000 to the square mile was maintained, with that of

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the United States, where, after less than one hundred years of cultivation, vast areas of soil are now almost worn out through improper methods that have taken no account of the correct utilization of waste. In Great Britain he detected a similar accelerated decay of farming; arable farming in particular had practically shrunk to the best areas only.

Sir Albert advocated that a beginning be made in the building up of a fertile soil by the proper use of dustbin refuse, which contains a large amount of impure cellulose and some animal matter, and is just what is needed for converting the stores of farmyard manure, still available on the land, into humus. It is exactly these materials—cellulose and lignin—that our manure heaps lack and which are necessary to the fungi and bacteria whose activities make humus. To quote the lecturer, "The ordinary manure heap is the weakest link in British farming; it is in urgent need of reform; it is biologically an unbalanced and unstable mixture containing far too little cellulose and far too much urine and dung. When we bring together three or four volumes of dustbin refuse and one volume of farmyard manure we have the ideal mixture for humus manufacture." The error in the past has been to regard town waste solely from the point of view of its chemical analysis—as a source of nitrogen, potash and phosphate—but if the needs of soil fertility are to be adequately served this material must be considered primarily as a source of humus.

Large-scale trials have been made by Sir Bernard Greenwell, Bart., at Marden Park, Surrey, with excellent results, and other trials, at Bodiam in Sussex, which used about 10,000 tons annually of finished humus prepared from pulverized town wastes, farmyard manure, old hop bine, hop string and all the miscellaneous waste of a hop garden of 500 acres, have produced a satisfactory improvement of the soil and the crop, and the all-in cost of the humus has been considerably less than that of an equivalent amount of artificial manures.

The best method of composting pulverized wastes was in large heaps on a warm sunny site facing south, protected from drying and cooling winds, explained Sir Albert. In the event of any danger of water-logging from below by storm water, the heap must be provided with a suitable catch drain. The materials are assembled in layers, first a layer of town and vegetable waste about 6 in. thick, then a layer of farmyard manure about 2 in. thick, followed by a good sprinkling

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of earth containing any wood ash or powdered chalk or limestone available. These layers are repeated until a height of about 4 ft. is reached. Each section should be completed separately and should be not more than 5 ft. across, so that vertical vents about 4 ft. apart can be made. The final width should not be less than 10 ft.

Temperature rises rapidly, and falls after three or four weeks, when the heap is turned from one end, the undecomposed material being carefully turned from the outside into the middle. The temperature again rises, and a second turn is given at the end of the month. After three months, there remains a dark powdery mass ready for application to the land.

Micro-organisms and the Preservation of Eggs

A Food Investigation Report recently issued by the Department of Scientific and Industrial Research* deals with the effects of micro-organisms—bacteria and moulds—in the preservation of eggs. How the organisms get into eggs, the rots and bad flavours they produce, Nature's means for preventing penetration and growth and scientific methods for assisting nature are all discussed.

It is stated that the opinion is generally held in the trade that "rots" are more numerous with eggs from old hens than from younger ones, and that fertilized eggs decompose more rapidly than unfertilized eggs. According to the report, the experimental evidence for both these opinions is indecisive. The number of "rots" is much higher, as would be expected, with eggs with dirty shells than with clean ones, but washing, or cleaning the shells in any way, is useless and in fact increases the rate of deterioration. The reason for this has apparently not yet been definitely established. It may be that washing removes the coating from a sound egg and thus renders it more susceptible to subsequent bacterial infection, or it may assist the passage of the bacteria already on the shell into the egg. Again, the coating of the substance called mucin deposited on the newly laid egg may itself have a germicidal action.

Since the spoilage of eggs, the report states, is due, above all, to microbiological activity, it follows on general grounds that all possible steps should be taken to reduce the infection at

* Microbiology in the Preservation of the Hen's Egg, Food Investigation Special Report No. 47. Price 2s. 6d.

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all points of handling. As hay and straw, in general, are known to harbour great numbers of micro-organisms, eggs should be kept out of contact with these materials as far as possible.

The report describes the commonest deleterious flavours or odours in stored eggs as "mustiness," "fishiness" and "cabbage-water" in the white, and a "strong" flavour in the yolk. The first three of these are micro-biological in origin. The cause of the last is not clear, but it has been suggested that a "strong" or "storage" taste appearing after about seven months' storage is due to the absorption of odours from the surroundings, especially from strawboard fillers.

Briefly the methods for reducing the spoilage of eggs by the activity of micro-organisms during storage are as follows: hygienic production and handling, coupled with strict elimination of all inferior material; preservation of the natural defences of the egg; control of temperature and of humidity, and the use of gases, such as carbon dioxide, or other means, such as sealing the pores of the eggs, for retarding the growth of the organisms.

Eggs to be cold stored should be cooled as rapidly as possible to temperatures near the freezing point of water. The result of work upon the control of humidity to avoid the possibility of fungal spoilage, indicates the humidity of the store should not exceed 80-85 per cent. Dealing with other methods for reducing the growth of micro-organisms, the report states that methods of storage depending on the exclusion of air, which prevent the growth of organisms needing oxygen, have been developed in a variety of ways. In the dry packing of eggs, salt, lime, bran, sawdust, ashes, sand and sulphur have all been used. None of these is completely successful in its objectives. Sealing with wax, with aluminium soap, or by immersion in waterglass is much better. The last method works well, eggs having been kept in good condition for several years by storage in waterglass. Its drawback, commercially, is the bulkiness of the preservative. Before sealing with wax, the eggs are frequently evacuated, and the wax may be applied hot. Partial sterilization, with better sealing of the pores, is thus accomplished.

The report gives considerable attention to the use of carbon dioxide in the storage of eggs. Commercial methods for the gas storage of eggs using carbon dioxide in conjunction with

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cold storage have been developed by the Low Temperature Research Station at Cambridge. These are described in Food Investigation Leaflet No. 8 (The Cold Storage and Gas Storage of Eggs), copies of which are obtainable gratis on application to the Secretary, Department of Scientific and Industrial Research, 16, Old Queen Street, Westminster, S.W.1.

Poultry Industry Bill

The following correction to the notice about the Poultry Industry Bill, which appeared in the last issue of the JOURNAL (pp. 105 and 106), should be noted. The paragraph relating to the marketing provisions of the Bill (the first paragraph on p. 106) should have read:—

The main purposes of the provisions relating to marketing will be to secure that home-produced eggs and poultry, when bought by consumers, are graded for quality and size, and that the responsibility for grading shall ordinarily be borne by the wholesale trade. After an appointed day, it will be an offence to sell a poultry product (i.e., dead poultry, eggs and egg products) unless it is graded and marked in the appropriate manner. Producers of eggs and poultry who sell their own produce by wholesale, sales of cooked poultry and cooked eggs, and hotel and restaurant sales, will not be subject to this requirement; and provision is made for the granting of such further exemptions as the Commission may decide upon.

Foot-and-Mouth Disease Research

The Foot-and-Mouth Disease Research Committee proposes to appoint a Scientific Superintendent of foot-and-mouth disease research. Valuable as the supervision of the Committee can be, the attention it can give must of necessity be intermittent and such a complex problem as foot-and-mouth disease requires the day-to-day services of the most skilled scientific worker available for the investigations.

Applications for the post have recently been invited, by means of advertisement, from scientists who possess recognized veterinary qualifications and who preferably have had practical experience of the management of farm animals under experimental conditions, together with considerable experience of pathological research, particularly in regard to virus diseases.

The Superintendent will take local charge of the Committee's

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Experimental Research Station at Pirbright, Surrey, and will be responsible to the Committee for the conduct of the experimental work, subject only to the requirements of the Ministry's officer at the Station in matters relating to the control necessary to avoid the risk of the spread of infection.

Trials of Potatoes for Immunity from Wart Disease, 1938

The trials which are arranged each year by the Ministry with the object of testing new varieties of potatoes for immunity from Wart Disease, were again conducted in 1938 on the farm of the National Institute of Agricultural Botany, Ormskirk, Lancashire. The actual field operations and the taking of records were carried out by Mr. Harold Bryan, B.Sc., and Mrs. McDermott, of the Institute, but the trials were conducted on a plan approved by the Ministry.

The approval of 35 new varieties has been recommended by an advisory committee, but only 5 of these have actually been added to the approved list. In the remaining instances inclusion has been postponed until such time as the raisers intimate that the varieties have actually been or will shortly be introduced into commerce. Descriptions of these new varieties are given below, together with similar particulars of two other varieties which had been recommended for approval in previous years and which are now being introduced into commerce.

EARLY VARIETY :—

Ulster Chieftain

- Sprout* .. Blue.
Tuber .. Oval; skin white; flesh white; eyes shallow to medium.
Haulm and Foliage. Low and compact, spreading later; stems slight, wing straight and narrow, leaf fairly large and open. No purple colouring in midrib. Leaflets large, thin and waxy. Secondary leaflets small.
Flowers .. White and seldom formed.

EARLY MAINCROP VARIETIES :—

Arran Bard

- Sprout* .. Blue.
Tuber .. Oval; skin white, netted; flesh white; eyes shallow.
Haulm and Foliage. Medium height, compact, bushy, spreading later; stems strong with much red purple colour particularly at the base; wing waved; leaves large, fairly open, some colour in midribs and on leaflet stalks; leaflets large, flat and of blue green colour; secondary leaflets small, not numerous.
Flowers .. Pale blue-purple, tipped white, fairly frequent; berries freely.

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Craigs Defiance

- Sprout* .. Pink.
Tuber .. Oval to long oval, flat ; skin white ; flesh white ; eyes shallow.
Haulm and Foliage. Medium height to tall, spreading ; stems of average strength, branching freely, mottled light pink ; wing waved ; leaf open, rigid ; leaflets oval, pointed, terminal leaflet drooping, medium to dark green, dull on top but older leaflets fairly glossy ; secondaries small, not numerous.
Flowers .. Purple, tipped white, not frequent ; anthers orange ; flower stalk often arising well down the stem ; buds pink.

Miss Vince

- Sprout* .. Pink.
Tuber .. Round inclined to be flat ; skin white ; flesh pale yellow ; eyes medium.
Haulm and Foliage Medium height, upright, bushy ; light yellowish green colour ; yellow growing point ; leaf erect, close ; leaflets oblong, pointed ; secondary leaflets medium size, numerous ; stems weak with slight purple colouration ; wings straight.
Flowers .. White, small and very infrequent.

Winder Gate

- Sprout* .. Pink.
Tuber .. Kidney ; skin white ; flesh pale lemon ; eyes shallow.
Haulm and Foliage. Upright bushy type, spreading later, irregular grower ; dark green colour ; leaf arched ; leaflets medium size, hard, leathery, wrinkled ; secondary leaflets small and few ; stems slightly serrated.
Flowers .. Red-purple tipped white, leafy bracts occur.

LATE MAINCROP VARIETIES :—

Mariae Bailiff

- Sprout* .. Pink.
Tuber .. Kidney ; skin white, netted ; flesh white ; eyes shallow
Haulm and Foliage. Medium height, dense, spreading ; dark green colour ; leaflets roundish, hard, wrinkled, glossy, crowded growing point ; secondary leaflets small and few.
Flowers .. Reddish-purple tipped white, small.

Neville Chamberlain

- Sprout* .. Deep pink.
Tuber .. Blunt kidney ; skin white ; flesh white ; eyes medium to deep.
Haulm and Foliage. Medium height, spreading ; dark green colour ; leaf open, drooping ; leaflets short and broad, hard, wrinkled ; secondary leaflets small ; wings slightly crinkled ; slight pink colouration of the stems.
Flowers .. Heliotrope tipped white.

The findings of the Potato Synonym Committee of the National Institute of Agricultural Botany have been accepted

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by the Ministry where recommendations as to the classification of new varieties as synonymous with existing varieties have been made by that Committee.

A list of the names of the more commonly grown varieties which have been approved as immune from Wart Disease may be obtained on application to the Ministry.

Tested Agricultural Machines

The value of thorough and impartial testing of agricultural machines and appliances has long been recognized, and for some years now the Ministry has operated a carefully-formulated scheme for the conduct of individual tests. Official certificates and reports are published giving accurate information on the performance of each machine tested. The main value of the scheme to the farmer is that he is able, as the prospective purchaser of a "tested" machine, to turn to an unbiassed and critical report* as a guarantee of what the machine has actually accomplished under the strict conditions under which it has been tested. Thus he may easily be saved from an unwise purchase, which, incidentally, is as disappointing for the manufacturer as for the farmer.

The following are the latest of the reports, which are published by H.M. Stationery Office:—

Alfa-Laval Combine-Recorder Milking Machine. (Certificates and Reports No. 69. Price 6d.) Over a period of nine months, which included both summer and winter conditions, the National Institute for Research in Dairying, Shinfield, tested this milking plant submitted for test by the Alfa-Laval Company, Ltd., Brentford. The plant tested consisted of 4 washing stalls, 6 milking stalls fitted with mangers and food rationing hoppers, a 3-unit milking machine equipped with devices for rinsing and for milk recording, releasing and sampling. The report gives details and results of the tests for the efficiency of the various parts of the plant, the accuracy of the devices, and the general design, convenience, and mechanical efficiency.

"Summit" Folding Milk-Sampling Plunger. (Certificates and Reports No. 70. Price 2d.) This metal plunger or agitator for mixing milk in churns prior to the taking of milk samples was entered for test by Messrs. Cope & Cope, Ltd.,

* A list of the reports issued can be obtained free on application to the Ministry, 10, Whitehall Place, London, S.W.1.

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Reading. The tests carried out by the National Institute for Research in Dairying were designed to ascertain the efficiency of the plunger for mixing milk, and its convenience in handling, ease of cleaning and portability. The report gives details of the tests.

Refresher Course in Animal Production

It is proposed to hold a Refresher Course in Animal Production at the Institute of Animal Nutrition, School of Agriculture, Cambridge, on July 9-15. The course (fee, £3) will consist of 12 lectures and 3 demonstrations and will deal with recent advances in such branches of animal production (including poultry) as nutrition, breeding, reproduction and disease.

The list of lectures and time-table will be available shortly. Further particulars may be obtained from Mr. J. Edwards, Livestock Advisory Officer, School of Agriculture, Cambridge.

Regrafting Fruit Trees by Frameworking Methods

It is regretted that the captions to two of the drawings which appeared in the above article in the May issue were incorrect; that on p. 181 should read Diagram 5.—*Awl-grafting*, and that on p. 184 should read Diagram 2.—*Side-grafting*.

WIRELESS TALKS, JUNE, 1939

<i>Station and Date</i>	<i>Time p.m.</i>	<i>Speaker</i>	<i>Subject</i>
NATIONAL :			
1	6.20	Eunice Kidd	The Poultry Industry
8	6.20	Mr. J. F. H. Thomas	Farming To-day.
15	6.20	—	Farming To-day.
22	6.20	—	Farming To-day.
29	6.20	—	Farming To-day.
WEST :			
8	6.40	Messrs. T. D. Corpe and A. W. Ling	The Law and the Farmer
15	7 30	—	Agricultural Bee.

APPOINTMENTS

County Agricultural Education Staff

Leicestershire : Miss M. A. Blore, B.Sc., N.D.D., as County Dairy Instructress. **Somerset :** Mr. E. J. Lovell as Warden at the Farm Institute.

PRICES OF ARTIFICIAL MANURES

Description	Average prices per ton (2,240 lb.) during week ended May 10th				Costs per Unit ¶
	Bristol	Hull	L'pool	London	
Nitrate of Soda (N. 15½%) ..	£ 8 0c	£ 8 0c	£ 8 0c	£ 8 0c	s. d. 10 4
" " Granulated (N. 16%) ..	8 0c	8 0c	8 0c	8 0c	10 0
Nitrate of Lime (N. 13%) ..	7 7e	7 7e	7 7e	7 7e	11 4
Nitro-Chalk (N. 15½%) ..	7 10c	7 10c	7 10c	7 10c	9 9
Sulphate of Ammonia :—					
Neutral (N. 20·6%) ..	7 14c	7 14c	7 14c	7 14c	7 6
Calcium Cyanamide (N. 20·6%)	7 19d	7 19d	7 19d	7 19d	7 8
Kainite (Pot. 14%) ..	2 18	2 15	2 15	2 15	3 11
Potash Salts (Pot. 30%) ..	5 4	5 1	5 0	5 1	3 5
" " (Pot. 20%) ..	3 15	3 12	3 12	3 12	3 7
Muriate of Potash (Pot. 50%) ..	8 10	8 8	8 5	8 8	3 4
Sulphate " (Pot. 48%) ..	10 2	10 0	9 17	10 0	4 2
Basic Slag (P.A. 15½%) ..	2 12b	2 5b	—	2 10b	3 2
" " (P.A. 14%) ..	2 8b	2 0b	2 0b	2 6b	3 3
Grd. Rock Phosphate (P.A. 26-27½%) ..	3 5a	3 0a	2 15a	2 10a	1 10
Superphosphate (S.P.A. 16%) ..	3 6h	—	3 2f	2 19g	3 9
" " (S.P.A. 13½%) ..	—	—	2 19f	2 16g	4 1
Bone Meal (N. 3½%, P.A. 20½%) ..	—	7 5	6 17h	6 12	—
Steamed Bone Flour (N. 4%, P.A. 27½-29½%) ..	4 15i	4 15	4 15h	4 10	—

Abbreviations : N. = Nitrogen ;

P.A. = Phosphoric Acid ;

S.P.A. = Soluble Phosphoric Acid ;

Pot. = Potash.

* Prices are for not less than 6-ton lots at purchaser's nearest railway station unless otherwise stated. Unit values are calculated on carriage-paid prices.

§ Prices are for not less than 2-ton lots, nett cash for prompt delivery, f.o.r., in town named, unless otherwise stated. Unit values are calculated on f.o.r. prices.

a Prices for 4-ton lots f.o.r. Fineness 85% through standard sieve.

b Prices for 6-ton lots. Prices at Bristol are f.o.r. Bridgwater ; at Hull and Liverpool f.o.r. neighbouring works, and at London f.o.r. at depots in London districts. Fineness 80% through standard sieve.

c For lots of 4 tons and under 6 tons the price is 1s. per ton extra, for lots of 2 tons and under 4 tons 5s. per ton extra, for lots of 1 ton and under 2 tons 10s. extra, and for lots of 2 cwt. and under 1 ton 20s. extra.

d Delivered in 5-ton lots at purchaser's nearest railway station. For lots of 2 tons and under 5 tons the price is 5s. per ton extra, for lots of 1 ton and under 2 tons 10s. per ton extra, and for lots of 4 cwt. and under 1 ton 20s. extra.

e For lots of 4 tons and under 6 tons the price is 1s. per ton extra, for lots of 2 tons and under 4 tons 5s. per ton extra, for lots of 1 ton and under 2 tons 10s. 6d. per ton extra, and for lots of under 1 ton 20s. extra.

f Prices shown are f.o.r. Widnes.

g Prices shown are ex works London : f.o.r. southern rails, 1s. 3d. extra.

h Prices shown are f.o.r. Appley Bridge.

i Price shown is f.o.r. Newport, Mon.

h Price shown is f.o.r. Avonmouth.

¶ These are calculated by regarding a ton as comprising 100 "units" (equal parts of 22·4 lb.) so that a fertilizer, for example, with 16 per cent. nitrogen contains 16 such "units" in a ton. Then, if the price per ton of such a fertilizer be divided by the percentage figure, the deduced cost is that of a "unit" of that agent. Those in the table above are based on London prices. (For further explanation, see Advisory Leaflet, No. 146, "The Valuation of Artificial Manures," obtainable from the Ministry free of charge.)

PRICES OF FEEDING STUFFS

Description	Price per ton	Manu- rial value per ton	Cost of food value per ton	Starch equiv. per 100 lb.	Price per unit starch equiv.	Price per lb. starch equiv.	Pro- tein equiv.
Wheat, British ..	£ s. 5 2	£ s. 0 9	£ s. 4 13	72	s. d. 1 3	d. 0.67	% 9.6
Barley, British Feeding ..	6 5	0 9	5 16	71	1 8	0.89	6.2
" Canadian—							
No. 3 Western ..	6 13	0 9	6 4	71	1 9	0.94	6.2
No. 4 Western ..	6 28	0 9	5 13	71	1 7	0.85	6.2
Dutch ..	6 78	0 9	5 18	71	1 8	0.89	6.2
Iranian ..	6 0*	0 9	5 11	71	1 7	0.85	6.2
Russian ..	6 15	0 9	6 6	71	1 9	0.94	6.2
Oats, English white ..	6 10	0 10	6 0	60	2 0	1.07	7.6
" " black and grey ..	6 10	0 10	6 0	60	2 0	1.07	7.6
Scotch, white ..	6 13	0 10	6 3	60	2 1	1.12	7.6
" Canadian—							
No. 2 Western ..	6 8*	0 10	5 18	60	2 0	1.07	7.6
No. 1 Feed ..	6 12	0 10	6 2	60	2 0	1.07	7.6
Mixed feed ..	6 5	0 10	5 15	60	1 11	1.03	7.6
Maize, American ..	6 13†	0 7	6 6	78	1 7	0.85	7.6
" Argentine ..	6 15	0 7	6 8	78	1 8	0.89	7.6
" Danubian Gal.							
Fox ..	6 10	0 7	6 3	78	1 7	0.85	7.6
Russian ..	6 10†	0 7	6 3	78	1 7	0.85	7.6
South African							
No. 2 White Flat	6 10†	0 7	6 3	78	1 7	0.85	7.6
Peas, Russian ..	6 10†	0 16	5 14	69	1 8	0.89	18.1
" Japanese ..	22 15†	0 16	21 19	69	6 4	3.39	18.1
Dari ..	8 0†	0 8	7 12	74	2 1	1.12	7.2
Milling Offals—							
Bran, British ..	5 7	0 17	4 10	43	2 1	1.12	9.9
" Broad ..	6 2	0 17	5 5	43	2 5	1.29	10.0
Middlings, fine, im- ported ..	5 10	0 14	4 16	60	1 5	0.76	12.1
Weatings† ..	5 17	0 15	5 2	56	1 10	0.98	10.7
" Superfine†	6 5	0 14	5 11	69	1 7	0.85	12.1
Pollards, imported ..	5 5	0 15	4 10	50	1 10	0.98	11.0
Meal, barley ..	7 12	0 9	7 3	71	2 0	1.07	6.2
" " grade II	7 0	0 9	6 11	71	1 10	0.98	6.2
" maize ..	7 0	0 7	6 13	78	1 8	0.89	7.6
" " South							
African	6 5	0 7	5 18	78	1 6	0.80	7.6
" " germ ..	6 15	0 12	6 3	84	1 6	0.80	10.3
" locust bean ..	7 5	0 6	6 19	71	1 11	1.03	3.6
" bean ..	9 7	0 18	8 9	66	2 7	1.38	19.7
" white fish ..	16 2	2 6	13 16	59	4 8	2.50	53.0
" Soya bean							
(extracted)† ..	9 10	1 12	7 18	64	2 6	1.34	38.3
Maize, cooked, flaked	7 12	0 7	7 5	84	1 9	0.94	9.2
" gluten feed ..	6 12	0 14	5 18	76	1 7	0.85	19.2

PRICES OF FEEDING STUFFS (continued)

Description	Price per ton	Manu- rial value per ton	Cost of food value per ton	Starch equiv. per 100 lb.	Price per unit starch equiv.	Price per lb. starch equiv.	Pro- tein equiv.
	£ s.	£ s.	£ s.		s. d.	d.	%
Linseed cake—							
English, 12% oil ..	9 15	1 2	8 13	74	2 4	1·25	24·6
" 9% " ..	9 2	1 2	8 0	74	2 2	1·16	24·6
" 8% " ..	8 17	1 2	7 15	74	2 1	1·12	24·6
Indian, 9% " ..	8 12†	1 2	7 10	74	2 0	1·07	24·6
Cottonseed cake,							
English, Egyptian							
seed, 4½% oil ..	5 15	0 19	4 16	42	2 3	1·21	17·3
Cottonseed cake,							
Egyptian, 4½% oil ..	5 10	0 19	4 11	42	2 2	1·16	17·3
Cottonseed cake,							
decorticated, 7-8% oil	7 15†	1 10	6 5	68	1 10	0·98	34·7
Cottonseed meal,							
decorticated, 7-8% oil	8 5†	1 10	6 15	70	1 11	1·03	36·8
Coconut cake, 5-6% oil	7 10	0 19	6 11	77	1 8	0·89	16·4
Ground nut cake, 6% oil	6 10*	1 0	5 10	57	1 11	1·03	27·3
Ground nut cake, de-							
corticated, 6-7% oil	8 10*	1 10	7 0	73	1 11	1·03	41·3
Ground nut cake, im-							
ported decorticated,							
6-7% oil ..	7 0	1 10	5 10	73	1 6	0·80	41·3
Palm-kernel cake, 5½% oil	7 0†	0 13	6 7	73	1 9	0·94	16·9
Palm-kernel cake meal,							
5½% oil ..	7 2†	0 13	6 9	73	1 9	0·94	16·9
Palm-kernel meal, 1-2%							
oil ..	6 10	0 13	5 17	71	1 8	0·89	16·5
Feeding treacle ..	5 0	0 9	4 11	51	1 9	0·94	2·7
Brewers' grains, dried ale	5 0	0 12	4 8	48	1 10	0·98	12·5
Brewers' grains, dried							
porter ..	4 12	0 12	4 0	48	1 8	0·89	12·5

* At Bristol.

§ At Hull.

† At Liverpool.

‡ In these instances manurial value, starch equivalent and protein equivalent are provisional.

NOTE: The prices quoted above represent the average prices at which actual wholesale transactions have taken place in London, unless otherwise stated, and refer to the price ex mill or store. The prices were current at the beginning of May, 1939, and are, as a rule, considerably lower than the prices at local country markets, the difference being due to carriage and dealers' commission. Buyers can, however, easily compare the relative values of the feeding stuffs on offer at their local market by the method of calculation used in these notes. Thus, if linseed cake is offered locally at £11 per ton, then since its manurial value is £1 2s. per ton as shown above, the cost of food value per ton is £9 18s. Dividing this figure by 74, the starch equivalent of linseed cake as given in the table, the cost per unit of starch equivalent is 2s. 8d. Dividing this again by 22·4, the number of pounds of starch equivalent in one unit, the cost per lb. of starch equivalent is 1·43d. Similar calculations will show the relative cost per lb. of starch equivalent of other feeding stuffs on the same local market. From the results of such calculations a buyer can determine which feeding stuff gives him the best value at the prices quoted on his own markets. The figures given in the table under the heading "manurial value per ton" are calculated on the basis of the following unit prices: N., 7s 9d.; P₂O₅, 2s. 6d.; K₂O., 3s. 8d.

FARM VALUES OF FEEDING STUFFS

The prices in respect of the feeding stuffs used as bases of comparison for the purpose of this month's calculations are as follow :—

	<i>Starch equivalent Per cent.</i>	<i>Protein equivalent Per cent.</i>	<i>Per ton £ s.</i>
Barley (imported)	71	6·2	6 7
Maize	78	7·6	6 15
Decorticated ground-nut cake	73	41·3	7 15
„ cotton-seed cake	68	34·7	7 15

(Add 10s. per ton, in each instance, for carriage.)

The Table below is issued as a guide to farmers respecting the feeding value of their crops in relation to current market prices. (The "food values," which it is recommended should be applied by Agricultural Organizers and other advisers in connexion with advisory schemes on the rationing of dairy cows, are given in the December, 1938, issue of the Ministry's JOURNAL, p. 965.)

FARM VALUES

Crop	Starch equivalent Per cent.	Protein equivalent Per cent.	Food value per ton, on farm £ s.
Wheat	72	9·6	6 19
Oats	60	7·6	5 16
Barley	71	6·2	6 14
Potatoes	18	0·8	1 13
Swedes	7	0·7	0 13
Mangolds	7	0·4	0 13
Beans	66	19·7	6 18
Good meadow hay	37	4·6	3 11
Good oat straw	20	0·9	1 17
Good clover hay	38	7·0	3 15
Vetch and oat silage	13	1·6	1 5
Barley straw	23	0·7	2 2
Wheat straw	13	0·1	1 3
Bean straw	23	1·7	2 3

FARM WORKERS' MINIMUM RATES OF WAGES

Agricultural Wages Board.—At a meeting held on April 24, 1939, Orders were made increasing the minimum weekly rate of wages in Merioneth and Montgomery (from 31s. 6d. per week of 52 hours in summer and 50 hours in winter to 32s. per week of 50 hours in summer and 48 hours in winter) and continuing unchanged the rates in Bedford and Huntingdon (34s.), Cumberland and Westmorland (35s. 6d. in summer and 34s. in winter), Durham (33s.), Northumberland (33s. 6d.) and Nottinghamshire (34s. 6d.). (The figures quoted are the minimum weekly wages for adult ordinary male workers.) The Orders also made directions with regard to holidays with pay, the number of days to be allowed as holidays for whole-time workers in regular employment for not less than 12 months being, in Cumberland and Westmorland, for male workers only, 7 days

FARM WORKERS' MINIMUM RATES OF WAGES

where employment is usually for a 7-day week and 6 days in other cases ; in Merioneth and Montgomery, 7 days for special class workers and 6 days for other workers, in Bedford and Huntingdon, Durham and Northumberland, 4 days, and in Nottinghamshire, 3 days. In all instances, holiday remuneration is fixed at daily rates proportionate to the minimum weekly rates. For full details of the minimum rates and holiday directions, and of the various provisions connected with them, reference should be made to the Orders, copies of which may be obtained free of charge from the Secretary, Ministry of Agriculture and Fisheries, Kings Buildings, Smith Square, London, S.W.1.

Enforcement of Minimum Rates of Wages.—During the month ending May 9, 1939, legal proceedings were taken against 7 employers for failure to pay the minimum rates of wages fixed by the Orders of the Agricultural Wages Board. Particulars of the cases follow :—

Committee Area	Court	Fines Imposed	Costs Allowed	Arrears Of Wages Ordered	No. of workers involved
		£ s. d.	£ s. d.	£ s. d.	
Cheshire ..	Macclesfield	6 0 0	0 7 0	23 18 6	2
Glamorgan	Llantrissant	*	1 11 6	14 7 1	1
Gloucester ..	Lydney ..	—	1 11 6	9 3 8	1
Hereford ..	Leominster	2 0 0	0 8 0	12 0 0	1
Norfolk ..	Downham Market.	2 13 0	0 15 0	11 5 10	2
Yorks (W.R.)	Snaith ..	3 0 0	—	9 5 0	1
Yorks (W.R.)	Snaith ..	2 0 0	—	4 8 0	1
	Totals ..	15 13 0	4 13 0	84 8 1	9

* Dismissed under the Probation of Offenders Act.

AGRICULTURAL INDEX NUMBER

MONTHLY INDEX NUMBERS OF PRICES OF AGRICULTURAL PRODUCE
(BASE, 1927-29 = 100)

Uncorrected for
Seasonal Variation

Corrected for
Seasonal Variation

Month	1937	1938	1939	1937	1938	1939
January ..	90	97	90	85	90	84
February ..	91	95	88	86	89	82
March ..	90	88	85	90	88	85
April ..	89	85	85	92	89	89
May ..	82	82		88	90	
June ..	81	81		89	90	
July ..	82	86		88	94	
August ..	83	81		87	86	
September ..	87	81		89	83	
October ..	93	86		89	82	
November ..	99	89		92	82	
December ..	100	90		92	82	

AGRICULTURAL INDEX NUMBER

THE SAME, TAKING ACCOUNT OF PAYMENTS UNDER THE WHEAT ACT (a),
THE CATTLE SUBSIDY (b), AND GOVERNMENT PAYMENTS FOR MILK (c).

Month	1937	1938	1939	1937	1938	1939
January	92	99	95*	86	93	89*
February . . .	93	97	93*	88	92	88*
March	92	91	90*	92	91	90*
April	90	88	90*	93	92	94*
May	83	84		90	92	
June	82	83		89	92	
July	83	88		89	96	
August	85	84*		89	89*	
September . .	89	84*		91	86*	
October	95	91*		91	86*	
November . . .	101	94*		94	86	
December . . .	102	94*		94	86*	

(a) Commenced August, 1932. (b) Commenced September, 1934.
(c) Commenced April, 1934. * Provisional.

NOTICES OF BOOKS

" Britain in Recovery." Prepared by the Research Committee of the Economic Science and Statistics Section of the British Association. Pp. xvi + 474. (London: Sir Isaac Pitman & Sons, Ltd., 1938. 15s.).

" Britain in Recovery " is the work of the same Research Committee appointed by the Council of the British Association which, under the Chairmanship of Professor H. Jones, produced " Britain in Depression." The two volumes provide a factual basis for an interpretation of the period of trade fluctuations between 1929 and 1937.

Following the main plan of the earlier volume, " Britain in Recovery " gives both a general account of the main features of the trade fluctuations and particular accounts of twelve important industries.

Part I includes an excellent " General Survey " of the whole period 1929 to 1937 and, in addition, the authors of the Sections on " Employment and Unemployment," " The Effects of Recovery on the Various Regions," " Industrial Relations," " Tariffs, Preferences and other forms of Protection," and " Foreign Exchanges," confine themselves, in the main, to the years of recovery. Professor Jones admits fault for the omission of a section on interest rates and investment. The book also suffers from the absence of any account of banking activities and an inconsiderable consideration of trade unionism. Professor Hall, however, provides one of the best statements available on the activities of the Exchange Equalization Fund and ventures to argue and to interpret.

Part II gives data for twelve industries, including agriculture. The account of agriculture during recovery is dealt with in three sections, " Grain and Other Crops," " The Milk Industry," and " The Livestock and Meat Trade." In general, they are straightforward factual statements on the position since 1933.

Sir Harold Bellman's section on the " Building Trades " is both interesting and refreshing. Other sections deal mainly with the " basic " industries and power and transport. But it is disappointing to find that relatively little consideration is given to the " new " industries.

NOTICES OF BOOKS

World Consumption of Wool, 1938. Imperial Economic Committee. (London: H.M. Stationery Office, 1939. Price 2s. 6d., post free 2s. 11d.)

According to this annual review published for the Imperial Economic Committee, a sharp fall occurred in the utilization of wool during 1938. Supplies were abundant, but the statistical position had been largely discounted by the fall in prices that occurred during the last quarter of 1937, and price fluctuations remained within fairly narrow limits.

Imports retained in the ten largest wool importing countries were lower than in any year since 1934, and unsold stocks on the primary markets at the close of the 1937-38 selling season (June) were larger than in any other recent year. Heavy reductions in purchases by the United States and Japan were the chief cause of the fall in imports.

The smaller requirements of those two countries more than offset the increased purchases by Germany and the replenishment of stocks by the United Kingdom and France.

In the United Kingdom, the industry was less active in all branches than in 1937 on account both of reduced home demand and smaller export business. Nevertheless, the industry continued to buy wool freely.

During the last half of the year the relative stability of wool prices at an extremely reasonable level encouraged wider competition on overseas wool markets, and although there was no immediate recovery in wool utilization, clearances during the opening months of the 1938-39 season were exceptionally good. The strength of the primary markets was not, however, sufficient to offset the general lack of confidence prevailing in most countries, and the cautious attitude to future commitments, together with restricted foreign trade, still combined to keep prices low.

Some improvement occurred during the opening months of 1939; clearances of wool continued heavy on primary markets and unsold stocks there are appreciably less than in either of the two previous seasons. Consuming activity has also improved in the United Kingdom, the United States and France.

An Introduction to Botany. By A. W. Haupt. Pp. xii + 396. Illus. (New York and London: McGraw-Hill Publishing Co. 1938. Price 18s.)

This book in the excellent series of text-books issued by the McGraw-Hill Publishing Co. is rather more than the usual introduction to botany normally required by first-year students reading for a university degree, and although intended to be a text-book, its style and the treatment of the subject remove it out of the category of those less inviting books issued mainly for instructional purposes. As a foundation for more advanced students the book should serve a very useful purpose. The book is well arranged, is very clearly written and contains a wealth of excellent illustrations.

Recent Advances in Plant Genetics. By F. W. Sansome and J. Philp. 2nd Edition. Pp. xii + 412, 55 illustrations and 49 tables. (London: J. and A. Churchill. 1939. Price 18s.)

It is gratifying and at the same time an indication of the interest which is being taken in the study of genetics that a second edition of this book should have been called for within a comparatively short time. So rapid has been the progress made in recent years in connexion with this field of study that it is difficult for any but the professional student to keep in touch with the later developments. To meet this need has been the purpose of the author, who may be congratulated on his systematic and clear treatment. To the teacher and research worker the book should be of definite value.

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No. 4

JULY 1939

The Agricultural Development Bill

The Agricultural Development Bill, which was introduced on June 6, embodies the Government's proposals for financial assistance to sheep producers, to growers of oats and barley and to those who plough up inferior grass land before October 31 next. Its main provisions are briefly as follows:—

Oats. Provision is made for the existing subsidy in respect of certain land under oats in the United Kingdom to be replaced by a subsidy applicable to all such land, the rate of subsidy being lower in the case of an occupier who obtains deficiency payments in respect of any wheat which may be grown on his farm. The higher rate per acre is to be 14 times the difference between the average United Kingdom price of oats and a standard price of 8s. with a maximum payment per acre of £2 6s. 8d., and the lower rate is to be 6 times the difference between 8s. and the average price, with a maximum of £1 per acre. The higher rate would, therefore, be payable in circumstances where the lower rate was payable under the Agriculture Act, 1937, and the lower rate in circumstances where no payment has hitherto been made. Provision is made for the standard price to be varied by order of the Ministers with the consent of the Treasury and the affirmative approval of Parliament. The price deficiency must be at least 3d. per cwt. before subsidy is payable. Maximum acreages for the United Kingdom are to be fixed on which the full higher or full lower rates of subsidy may be paid, and if the acreage qualifying for subsidy at either rate exceeds the maximum acreage prescribed for that rate, the rate is to be proportionately reduced.

Where the crop has been prejudicially affected by negligent cultivation or where the land has been cropped in a manner calculated to impair its fertility the subsidy may be reduced or withheld.

It is proposed that these new subsidy provisions shall apply also to land under oats on June 4, 1938, and any subsidy payment already made under the Agriculture Act, 1937, will be treated as an advance payment of subsidy at the proposed new rate.

The subsidy for oats is estimated to cost an additional sum of £2,120,000 in respect of the 1938 crop, and to involve a maximum liability of £4½ million in any one year.

Barley. In respect of land under barley on June 4, 1938, the Bill provides for subsidy payments at the same rates and on the same conditions as for oats, at an estimated cost of £800,000.

As regards the future, provision is made for a scheme or schemes to be submitted to Parliament by the Agricultural Ministers to ensure barley growers an adequate market and to safeguard their returns. These schemes may require users of barley for malting purposes to pay prices not lower than those prescribed, and to use not less than prescribed quantities; or alternatively the schemes may leave the malting barley market relatively free and supplement by subsidy the price received by producers for such barley to ensure a given average return. Under either scheme that portion of the barley crop not sold for malting purposes is to be guaranteed an average standard price of 8s. per cwt. by means of an Exchequer contribution. As in the case of oats, provision is made for varying the standard price.

Should a minimum price scheme be introduced, a separate arrangement would be made to enable barley growers to receive subsidy up to a maximum of £2 13s. 4d. per acre in respect of that part of their output of barley not bought for the purpose of malting, while under a subsidy scheme the Exchequer contribution would be added to a fund to be fed also by levies upon users of barley for malting.

For 1939, provision is, however, made for a simplified scheme on a levy subsidy basis owing to the short time available for instituting either type of long-term scheme mentioned.

Provision is made for the constitution of a Barley Advisory Committee, consisting of representatives of the interests concerned, to advise Ministers upon matters connected with barley schemes.

Sheep and Lambs. The Bill provides for deficiency payments to be made, under a scheme to be prepared by the Livestock Commission, to owners of certain classes of fat sheep and lambs bred, and sold or slaughtered, in the United Kingdom when prices of fat sheep fall below certain levels. Payments in respect of eligible sheep are to be made monthly, and to be equal to any deficiency of the average market price of fat sheep below a monthly standard price multiplied by a prescribed standard weight varying with the class of sheep and period of the year. The monthly standard prices are to be related to an annual basic standard price of 10d. per lb. of dressed carcass weight, reduced if necessary in accordance with successive increases of 250,000 in the United Kingdom sheep population above a standard sheep population of 27,000,000. Provision is made for the reduction of the standard population below 27,000,000 when the average annual market price is below the annual standard price in each of the two successive years, and there is further provision for restoring the original level of the standard sheep population when annual market prices rise above the annual standard price.

Eligible classes of sheep are to be defined by regulations, and provision is made for marking imported sheep, which are not to be eligible for subsidy, and for controlling the entry into the United Kingdom of sheep from Eire and the Isle of Man.

The annual cost to the Exchequer of sheep deficiency payments may be expected to vary considerably from year to year and cannot be estimated closely, but on certain broad assumptions it is estimated that deficiency payments, had they been in operation in 1938, might have reached £2½ million.

Ploughing Up of Grass Land. Part IV of the Bill enables grants to be made of £1 per half acre, for a minimum area of two acres, towards the cost of ploughing up between May 4 and October 31, 1939, land which has been under grass for not less than seven years and of bringing such land into a condition of cleanliness and fertility so that it would, were the need to arise, be capable of growing satisfactory arable crops in the year 1940. Alternatively, it is contemplated that the land would, in the main, be re-sown to grass, thereby effecting a very desirable improvement in the pastures of the United Kingdom. Certain conditions are laid down, and it is

provided that any grant payable shall be taken into account in assessing compensation for improvements payable to a tenant upon a change of tenancy. On the assumption that 250,000 acres may be ploughed up, the cost to the Exchequer would be £500,000.

Agricultural Machinery Reserves. The Minister of Agriculture and Fisheries is to be given power to establish, with the concurrence of the Treasury, a reserve of tractors and other agricultural machinery which would be used, should the need arise, for increasing the home production of food. A supplementary estimate of £1,250,000 for this purpose was agreed to by the House of Commons on May 22, 1939.

Assistance for Agricultural Credits. Provision is made for the payment to the Agricultural Mortgage Corporation established under Part I of the Agricultural Credits Act, 1928, of not more than £60,000 per year for 20 years. These payments would enable the Corporation to continue to make loans at the existing rate of $4\frac{1}{4}$ per cent. The necessity for such assistance arises from the fact that the Corporation's loanable capital was borrowed at $4\frac{1}{2}$ per cent. and 5 per cent. interest, having been raised by the issue of debentures prior to the general fall in interest rates in 1932.

Reserves of Feeding Stuffs

In reply to a question in the House of Commons on June 12, the Minister made the following statement:—

“ There are, of course, considerable supplies of feeding stuffs in the country and in the event of grave emergency arising, the Government would take steps to control supply and distribution. It will be appreciated, however, that there might be difficulties in distribution in the initial period and farmers would therefore be serving not only their own but also the national interest if, with due regard to the nature and extent of their normal requirements, they created and maintained a small reserve of feeding stuffs to supplement available supplies over the first few weeks of an emergency period. Since it is probable that all wheat will be required for human consumption, any stocks of wheat held by farmers should not be regarded as available for feeding purposes, but temporary provision for the early stages of an emergency period could with advantage be made

by keeping larger stocks of, say, barley, oats, and maize, whether as grain or as meal, oilseed cakes, and manufactured concentrates, according to individual needs.

Such a reserve would not only form a useful addition to the total stocks of feeding stuffs held in the country, but would obviate any immediate shortage in individual cases as the result of undue strain on distribution in the early days of a war.

I should emphasize, however, that if farmers decide to create reserves, they should do so while conditions are normal and not wait until a serious crisis develops. Hurried purchases of feeding stuffs in time of crisis would embarrass and not assist the authorities."

Science and the Farmer

The rapidity of the progress achieved by agricultural science in recent years has made it difficult for most working farmers to keep pace with modern developments, and, with the ever increasing specialization that characterizes all contemporary scientific research, the literature of the subject becomes increasingly difficult for the general reader to understand. The farmer who wishes to keep up to date in his knowledge of investigations that have a bearing on agricultural practice must frequently experience the need for an explanatory guide or refresher course to facilitate his reading. Several readers of the JOURNAL have, in fact, expressed their desire for such a guide, and it has, therefore, been arranged to publish a series of articles, under the title of *Science and the Farmer*, which should serve this purpose.

These articles will explain as far as is possible in non-technical language some of the basic scientific principles underlying agriculture, and present a brief review of modern knowledge in some of the more important departments of the subject. For instance, the series will include articles on soil colloids and soil reaction; mineral salts in plant nutrition; the fermentation of organic matter; soil nitrogen; plant genetics; the nature of plant disease; animal genetics; animal nutrition, etc., etc. The series, which will cover about a dozen articles, will be contributed by Professor Scott Watson, who needs no introduction to readers of this JOURNAL. The first article of the series appears on pp. 379-386 of this issue.

HOUSING THE RURAL WORKER

R. T. SHEARS,

Devon County Council Office

When introducing the Housing (Financial Provisions) Bill to the House of Commons in February of last year, the Minister of Health, the Right Hon. Sir Kingsley Wood, stated that since the Armistice more than three and a half million houses* had been erected in England and Wales by Local Authorities, private enterprise and voluntary action, but that in spite of this gigantic figure sufficient provision had not been made for that section of the people who are so vital to the nation, namely, agricultural workers. There were three ways in which this could be done, namely, by improving sound old houses, by demolishing and replacing bad houses, and by providing new houses for normal needs.

In addition to the powers possessed by Local Authorities, unparalleled opportunities now exist to enable farmers, land-owners and others to provide modern housing accommodation for agricultural workers, either by reconditioning old houses or by providing new ones, and it is well to note that these facilities will remain in operation until September 30, 1942.

The exodus of the farm worker from the countryside has been a problem which has caused deep concern to agriculturists for many years past, and one of the principal causes has undoubtedly been the lack of cottages of a modern standard, and the shortage, or total absence, of proper water supplies in the villages. It is true that large numbers of "council" houses were provided in agricultural parishes between 1920 and 1930, but generally the rents charged have been much too high for agricultural labourers to live in them. In one rural district, out of 230 houses built under the "Wheatley" Act of 1924 only 12 were let to agricultural labourers, the remainder being inhabited by persons of independent means, farmers, school teachers, ministers of religion, railway workers, postmen, motor drivers, grooms, bricklayers, and so on. The rent charged for these houses was 7s. 6d. per week, with rates in addition.

As a result of high rents and the extremely poor standard of the other accommodation available, many of the best workers were compelled to seek accommodation in the outskirts of the towns, often at some distance from their occupation, thus helping to intensify the already fierce competition

* Four million new houses have now been completed.

HOUSING THE RURAL WORKER

for "council" houses provided by borough and urban authorities, and at the same time aggravating to a very considerable extent the problem of overcrowding in the urban areas.

Facilities Available. The facilities available to private owners for dealing with the problem are:—

RECONDITIONING UNDER THE HOUSING (RURAL WORKERS) ACTS. Briefly, these Acts authorize certain Local Authorities, usually County Councils, to make a grant of a maximum of £100 per dwelling for complete reconditioning costing £150 or more, provided the owner agrees to let the cottage for a period of twenty years to agricultural workers, or persons of similar economic standing, at a rental determined by the Local Authority making the grant.

Where the cost of reconditioning is less than £150, then a grant of up to two-thirds of the cost is made; no application can be entertained where the total cost of the works is less than £50, or where the estimated value of the cottage, when the work is finished, exceeds £400.

Generally, Orders made under the Agricultural Wages Act fix the amount to be deducted from workmen's wages at 3s. per week, but if the tenant is not an agricultural employee of the owner the rent can be increased by 4 per cent. on the owner's net outlay. The following examples give a clearer idea of the scheme:—

						£
A.	Cost of works	..	..	..	..	135
	Grant (two-thirds)	..	..	..	..	90
	Owner's outlay (one-third)	..	..	..	..	45
	Increase of rent permitted (where tenant not agricultural employee of owner)	..	..	..	..	8d. per week
B.	Cost of works	..	..	..	..	150
	Grant (two-thirds)	..	..	..	..	100
	Owner's outlay (one-third)	..	..	..	..	50
	Increase of rent permitted	..	..	..	..	9d. per week
C.	Cost of works	..	..	..	..	200
	Grant (maximum)	..	..	..	..	100
	Owner's outlay	..	..	..	..	100
	Increase of rent permitted	..	..	..	..	1s. 6d. per week

Where the owner is unable to find the balance between the cost of reconditioning and the amount of the grant, the Council may make the owner a loan of the balance at a low rate of interest, repayable over a period of twenty years.

It is possible, therefore, subject to certain conditions, for the owner of any cottage tenanted by an agricultural worker to have it thoroughly modernized at the public expense without

HOUSING THE RURAL WORKER

laying out a farthing from his own pocket until the expiration of six months, when he would be called upon to pay the first half-year's instalment (principal and interest combined) on his loan which, in example B, would be £1 15s.

PROVISION OF NEW HOUSES UNDER THE HOUSING (FINANCIAL PROVISIONS) ACT, 1938. Under this Act it is possible to obtain from the Government a grant of as much as £10 a year for forty years towards the cost of building new cottages, provided they are let to members of the agricultural population " at a rent which by any order of the appropriate agricultural wages committee in force at the time of letting is determined as the value at which the benefit or advantage of a cottage is to be reckoned as payment of wages in lieu of payment in cash." This means, as a rule, 3s. per week. The grant is available to any person wishing to build if the Local Authority is satisfied that the housing accommodation can be more conveniently provided by him than by themselves, and it is available, for instance, to agricultural workers who wish to build houses for their own occupation.

County Councils are not primarily concerned with the administration of this Act. All applications have to be submitted to the District Councils, and if on examining the proposals they are of opinion that the suggested cottages are needed for agricultural workers, and the necessary conditions can be complied with, the District Council forward the applications to the Ministry of Health with a note of the amount of annual subsidy recommended.

A plan and layout of the house or houses must be forwarded with the application, and also a certificate from the Surveyor to the Council that the houses—

- (a) are in compliance with the requirements as to size, materials, density, type of construction, etc., approved by the Minister of Health for houses to be built by local authorities ;
- (b) are to be of entirely new construction and of a type for which a loan period of not less than 60 years is allowed to a local authority by the Minister of Health ;
- (c) will not prejudice or conflict with the requirements of any planning scheme made or likely to be made in respect of or in the neighbourhood of the area in which the houses are to be provided.

The Ministry of Health decide each application on its merits and it is to be noted that the consents of both the Local Authority and of the Ministry must be obtained prior to building. Grant is paid annually through the Local Authority, but no contribution is paid for any year unless the requirements as to

HOUSING THE RURAL WORKER

occupation and rent are observed, and unless reasonable steps have been taken to secure the maintenance of the house in a proper state of repair during the year.

The following examples show how an owner may meet the cost of providing new houses under this Act:—

	£	s.	d.	£	s.	d.
A. All-in cost of building pair of cottages—say				1,000	0	0
<i>Expenditure :</i>						
Annual cost to owner of rentcharge* to repay principal and net interest £4 9s. 8d. \times 10 (for 40 years)					44	16 8
<i>Income :</i>						
Annual Government Subsidy :						
Two houses at £10 (for 40 years)	20	0	0			
Annual Rent :						
Two houses at £7 16s.	15	12	0			
Net annual cost to owner of providing two cottages	9	4	8			
				44	16	8
B. Alternative Scheme where owner is able to contribute £200 cash toward cost of pair of cottages :						
All-in cost (£1,000 less £200)				800	0	0
<i>Expenditure :</i>						
Net Rentcharge (as above) on £800 :						
£4 9s. 8d. \times 8				35	17	4
<i>Income :</i>						
Government Subsidy	20	0	0			
Annual Rent	15	12	0			
Net cost of providing 2 cottages :				35	12	0
£200 cash and 5s. 4d. a year for 40 years.						

Progress under the Acts. The "Reconditioning" Acts have been in operation since 1926. Progress at first was slow, and by 1931, when the original Act was due to expire, only 4,500 cottages had been dealt with in England and Wales. The Act was extended for a further five years, and by March, 1931, the number reconditioned amounted to 10,256. Of this total Devon was in the lead with 1,446 and East Suffolk (with a rural population of one-half that of Devon) next with 784.

The Housing Act of 1935 extended the facilities for reconditioning to June, 1938, and the Housing (Rural Workers) Amendment Act of that year gave cottage owners yet further opportunities for "putting their houses in order" by again extending the date for the receipt of applications to September 30, 1942.

* The "rentcharge" mentioned above has been calculated on the basis prescribed in the very useful brochures issued recently by the Lands Improvement Company, of 58, Victoria Street, Westminster, S.W. A study of these would repay any agricultural landowner who is interested in the provision of new cottages.

HOUSING THE RURAL WORKER

It is now evident that at long last, after constant official pressure and encouragement, owners in country districts are definitely facing up to their responsibilities, and activity on the rural housing front has never been greater than at the present moment. At the end of 1938, a total of 17,625 houses had been completely reconditioned and work on a further 2,564 was in progress, making a grand total of 20,189.

The Counties in which the greatest activity has taken place are:—

<i>England</i>	<i>No. of Dwellings</i>	
	<i>Assistance Promised</i>	<i>Assistance Given</i>
Devon	2,022	1,820
Essex	1,162	958
Shropshire	1,072	908
Cumberland	1,017	730
Lincoln (Holland, Kesteven and Lindsey)	974	792
East Suffolk	935	888
Norfolk	911	773
Hampshire	848	765
Cornwall	854	758
Wiltshire	755	622
Somerset	723	580
<i>Wales</i>		
Pembroke	493	366
Montgomery	293	257

In Shropshire, Cornwall and Lincs (Kesteven) the Acts are administered also by certain Borough and Urban District Councils.

In Devon, the County Council have recently issued their two-thousandth Certificate of Approval, and this means that the County Council have been called upon to find £200,000 in grants besides the cost of architectural assistance, office administration, supervision, etc. One-half the loan charges are defrayed by the Government, and the amount falling on the County rate for a period of twenty years is approximately £7,250 in loan charges, and £750 a year in administration. Altogether, these sums represent a rate of approximately two-thirds of one penny in the £.

The cost of the Devon scheme, therefore, to the occupiers of a house rated at about £100 net rateable value is no more than 6d. a month, and to the tenant of a cottage rated at £5 a year the rate burden is about one-farthing per month.

The County Council of Devon have never shirked their duties under the Housing Acts. Every request made to them by the Housing Committee has been sympathetically con-

HOUSING THE RURAL WORKER

sidered, and the Finance Committee, in times of financial stress as well as in times of plenty, have readily provided the necessary funds to enable the Committee to make grants and loans in every case they thought fit.

This policy, as the accompanying photographs show, has done much to improve the amenities of rural Devon. Many of these reconditioned cottages are situated in isolated country districts, and, indispensable as they are to workers on the land, they may also in times of national emergency prove havens of rest for families or children evacuated from more vulnerable areas.

It is early yet to anticipate the extent to which advantage will be taken by private enterprise under the Housing (Financial Provisions) Act, but it has had an encouraging start. The Act received Royal Assent on March 30, 1938, and up to March, 1939, the number of new houses for agricultural population for which the Ministry of Health had promised assistance was 525. Of this number, however, only 38 related to Devon.

From the point of view of public funds, reconditioning is by far the least expensive method of providing up-to-date housing accommodation. Thoroughly to recondition a cottage may cost anything from £100 to £300. The average cost throughout the country is about £200 per dwelling, and the average grant, which is provided in equal shares by the Local Authority and the Government, £90 per dwelling.

To provide a new cottage for an agricultural worker will probably cost the Rural District Council from £400 to £500, including site, roads and drainage. In order that they may be let at a low rent to agricultural workers, many of whom earn less than £2 per week, the Government and Local Authorities provide subsidies of from £12 to £16 a year for forty years. This is equivalent to a capital grant from public funds of from £237 to £316.

To provide a new cottage by private enterprise under the 1938 Act will cost the Government £10 per annum for forty years or the equivalent of a capital grant of £205 10s. 2d., so that with interest at 4 per cent. the comparative cost to the public is:—

Reconditioning	£	90 per dwelling
New cottages erected by District Council up to	316	..
New cottages erected by persons other than a		
Local Authority up to	205	..

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Preservation of Amenities : TOWN AND COUNTRY PLANNING. Rural housing is definitely related to planning, and the greater part of the rural areas of the country is now covered by Planning Schemes controlled either by District Councils or by Regional Planning Committees.

Usually the first intimation that the farmer or landowner receives about planning is in the shape of a foolscap, printed notice, plentifully splashed with whereases, asterisks, daggers and parentheses and purporting to declare for the information of all who care to read :—

that the Minister of Health has approved a resolution of the Planning Committee deciding to prepare a planning scheme that the recipient is the owner or occupier of a hereditament in the area

that a map showing the area proposed to be planned is on deposit at a certain defined place

that an owner can register his name with the Planning Authority for the service of subsequent notices relating to the scheme, and

that any suggestions should be forwarded to the Clerk or Secretary to the Committee.

It needs almost an expert legal mind to deduce this information from the printed form, but most planning authorities make it a practice to circulate to any interested person a brochure setting out the aims and objects of a Planning Scheme.

In every country planning scheme provision is made for the protection of villages of a particularly beautiful character by defining them as special village areas, and all building plans relating to premises in those areas have to be forwarded to the Regional Planning Office for consideration. Photographs of special village areas are given in Figs. 9 to 11, and it would be an act of spoliation if building or reconditioning were permitted in these picturesque villages that would in any way conflict with their natural amenities.

Another point of exceptional interest in connexion with planning is the prescription of "rural zones," and the Ministry of Health have recently issued a memorandum (No. 1,750) to all Councils and Planning Authorities on this question. Land which is genuinely rural in character and is likely to remain so in the future, has to be included in a rural zone in which only buildings required in connexion with agriculture, horticulture, etc., will be permitted. Country dwellings will be permitted only if a certain area of land, varying from 5 to 50 acres, as required by the Planning Authority, is attached to them.

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Dwelling houses for the occupation of persons employed on the land, buildings for rural industries and buildings required in connexion with the winning of minerals are *not* affected by the proposals.

In all cases where application is made for consent to erection of buildings for other uses, the Authority has to decide whether to give or withhold consent and, in dealing with applications, consideration must be given as to whether the buildings are likely to injure the amenities of the neighbourhood or to involve danger or injury to health by reason of the lack of sewers, water supply or any public services; or that the provision of necessary services would be premature or likely to involve unnecessary expenditure of public money.

It is important, therefore, that any rural landowner desirous of developing his estate, should seek information and, if desired, advice, from the Local Authority or from the Regional Planning Officer, before any definite steps are taken.

A section of a regional map showing the new rural zone is printed opposite.

Reconditioning in Devon. Figs. 1 to 8 illustrate the type of cottages which have been the subject of reconditioning in Devon. In certain parts of the county quite a number of rural workers live in their own cottages and, with the help of the grant and loan, the occupiers are able to do what previously had been entirely beyond their means.

In some villages nearly three-fourths of the dwellings available for agricultural workers have been reconditioned. In others, however, all the cottages in the village are owned by one person and complete reconditioning of all of them is a very heavy financial responsibility.

Several years ago it became necessary for a number of cottages in the village of Ilsington, near Haytor, Dartmoor, to be reconditioned in order to comply with the requirements of the Local Sanitary Authority. The owner could not afford to do this and offered them to the Rural District Council.

The District Valuer, however, was not prepared to recommend the Ministry of Health to approve the price agreed to be paid by the District Council and the matter was left in abeyance.

The property was subsequently acquired by a gentleman who, knowing of the extremely unsatisfactory conditions under

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which the tenants were living, determined to restore the whole of the cottages, which, apart from four new houses erected by the District Council, comprised the entire working-class housing accommodation in the village.

A start was made with the pair of thatched cottages shown in Figs. 12 and 13, then with the three on the lower side, (Figs. 14 and 15). Their restoration is a splendid example of the preservation of village amenities. The village smithy, no longer required in this petrol-driven age, has been successfully converted into a bungalow with ample accommodation for a large family. In the same row on a lower level two further cottages have been completed (Figs. 16 to 18), whilst work is about to be commenced on the last remaining block of four.

The owner, who has personally supervised the work, met with considerable constructional difficulties during the course of his scheme, it being a common occurrence to come across stone walls 8-10 ft. thick through which it was necessary to cut openings for larder and staircase windows, waste-pipe, drains, etc. Every cottage has a bathroom, electric light and other necessary modern conveniences.

Reconditioning would not have been possible but for the assistance provided under the Housing (Rural Workers) Act, and the cottages, ere this, would have been scheduled for demolition.

CONVERSIONS. It should be noted that grants are also available for the conversion into dwellings of premises not previously used for that purpose and Devonian architects have exercised remarkable ingenuity in adapting disused barns, stables, schools and chapels into modern dwellings.

Within the past year an ancient Dartmoor woollen mill has been converted into a block of seven cottages. Every dwelling has gas laid on for lighting and cooking; each house or flat has its own bathroom, kitchen, scullery, larder and other modern conveniences foreign to agricultural workers' cottages in the locality.

Another extremely interesting conversion is that of a North Devon Georgian-style residence, which at the moment is being converted into six rural workers' dwellings. The new owner has exercised considerable skill in dividing the premises and the larger rooms without gutting the interior in order that each dwelling shall have its living-room, kitchen and scullery on the ground floor, and three bedrooms, bathroom and lavatory

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on the first floor. Electric lighting and gas has been installed. The exterior of the house has not been altered. A portion of the grounds in front will be common to all the occupiers, whilst each house has its drying-yard at the rear. There are large kitchen-gardens near by, and every tenant will have the option of renting a portion, if desired.

COMPLIANCE WITH CONDITIONS. In Devon more than one-half the reconditioned cottages are let to farm workers in the employ of the cottage owner, and no tenancy difficulty arises in these cases because the rent, 3s. per week, is fixed under the Agricultural Wages Act and may be deducted from the workers' wages.

In other cases, however, the owner may charge the increase of rent mentioned on p. 319, and the occupier must be a person whose income is such that he would not ordinarily pay a rent in excess of that paid by an agricultural worker.

The average rent of all the cottages reconditioned in the Rural Districts of Devon works out at approximately 4s. per week. Where the owner has to incur considerable expense, and the dwelling is not a service cottage, it follows that he may be entitled to charge quite a considerable rent if the average rent for the five years prior to reconditioning is on the high side. For example, a cottage before reconditioning may have been let at £10 per annum, as many country cottages are, and if the cost of works is £250 the owner is entitled to add another £6 to the rent (4 per cent. on £150).

All classes of rural workers, in addition to agricultural labourers, appear to occupy reconditioned cottages, and the eligibility of the proposed tenant is a matter within the discretion of the Local Authority making the grant. The income of the occupier, so far as it can be ascertained, is generally taken as a guide to eligibility. In the rural districts of Devon no person who earns more than 45s. per week can reasonably be said to be of similar economic standing to an agricultural worker.

Smallholders who are owners of their holdings have always been eligible for assistance under the Act, provided, of course, their income is within the prescribed limits. It is rarely possible to estimate the exact income which a smallholder derives from his holding, and it is often difficult to say at what stage a smallholding becomes a farm. The Small Holdings and Allotments Acts of 1908 and 1926 define a smallholding as an agricultural holding which exceeds one acre

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and either does not exceed fifty acres, or, if exceeding fifty acres, is at the date of sale or letting of an annual value for purposes of income tax not exceeding £100.

The Devon Housing Committee have decided that they will be prepared, as a matter of routine, to approve applications where the holding is not over 40 acres, and where the rent is not more than £50 per annum. Where these limits are exceeded the application is referred to the Small Holdings Surveyor for a special report, and if he states that in his opinion the tenant would not, in the ordinary course, earn substantially more than an agricultural worker, the application is approved. Provision is made in the Housing Act, 1935, to enable an appropriate grant to be paid to County Councils for the reconditioning of their smallholders' cottages.

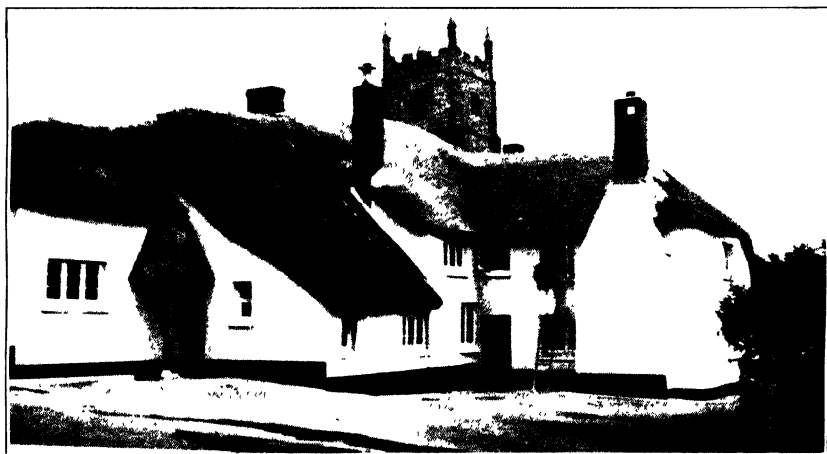
During each of the twenty years covered by the Act owners of reconditioned cottages have to satisfy the Local Authority that the tenancy conditions laid down by the Act are being complied with, and that all reasonable steps have been taken to secure the maintenance of the dwelling in a fit state for a working-class habitation.

Surprise inspections are undertaken by the Local Authority from time to time, but generally there has been very little evidence that owners of reconditioned cottages are attempting to evade the conditions under which the grant is given. If any cases are brought to light the grant has to be refunded, with interest in addition.

An owner who desires to rid himself of the conditions can do so by applying to the Local Authority for consent to refund the grant. Up to 1938 he could do so by refunding the whole of the grant plus compound interest, but now he is only required to refund a portion of the grant, taking credit for the period during which the cottage has been occupied by an agricultural worker. For example, an owner who received a grant of £100 five years ago would have to refund 15/20ths of £100, equals £75, plus compound interest at, say, 4 per cent. for five years, namely £16 5s.; or £91 5s. in all.

During the period the Act has been in operation in Devon, sums amounting to £4,243, including interest, have been refunded voluntarily or recovered for breach of conditions in connexion with 41 dwellings.

There is no restriction on the sale of any dwelling after the grant has been given, but the conditions, being attached to the dwelling itself, must remain applicable for the twenty years

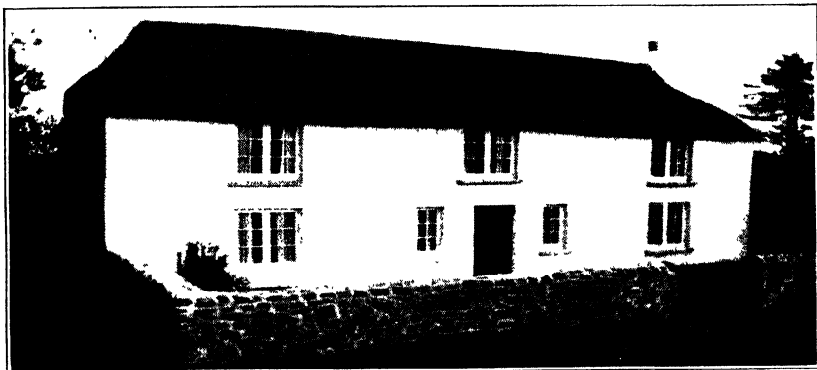


FIGS. 1 and 2 Cottages at Drewsteignton, Devon, before and after reconditioning under the Housing (Rural Workers) Acts

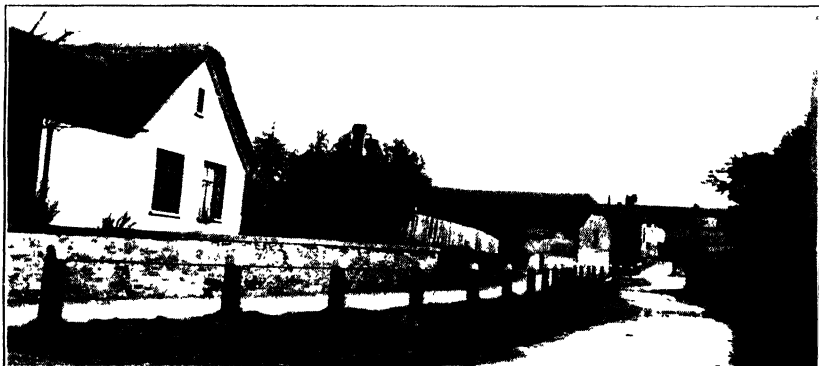
(The photographs in this inset are Copyright by Mr. R. T. Shears.)



FIGS 3, 4 and 5 Typical Devonshire cottages before reconditioning



FIGS. 6, 7 and 8 The same blocks of cottages after reconditioning



FIGS. 9, 10 and 11 Town and Country Planning Special village areas in East Devon

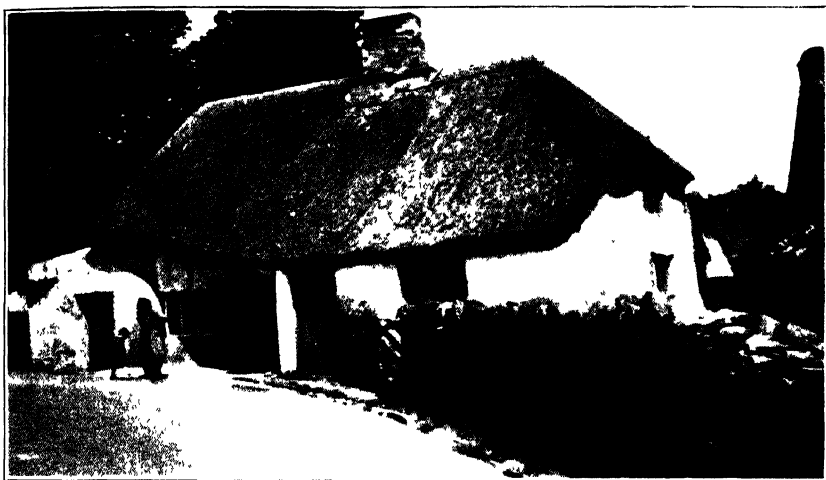
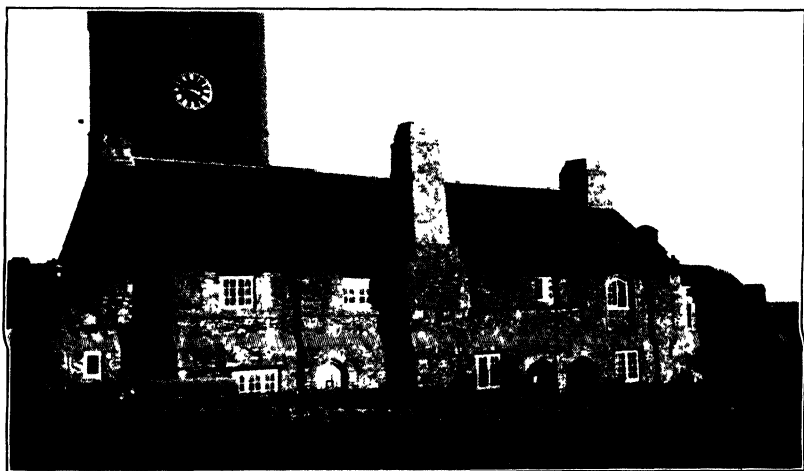


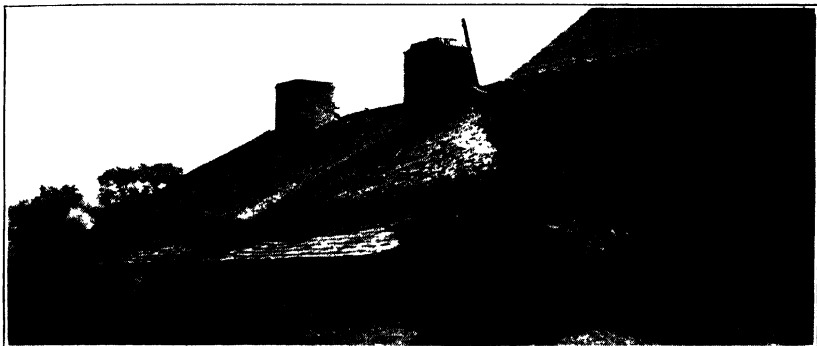
FIG. 12 — Pair of Devonshire cottages — picture-que — but quite unfit for human habitation



FIG. 13 — The same cottages, modernized — but retaining all their external charm



FIGS. 14 and 15 Replanning a village with assistance under the Housing (Rural Workers) Acts. Details of this interesting experiment are given on page 326

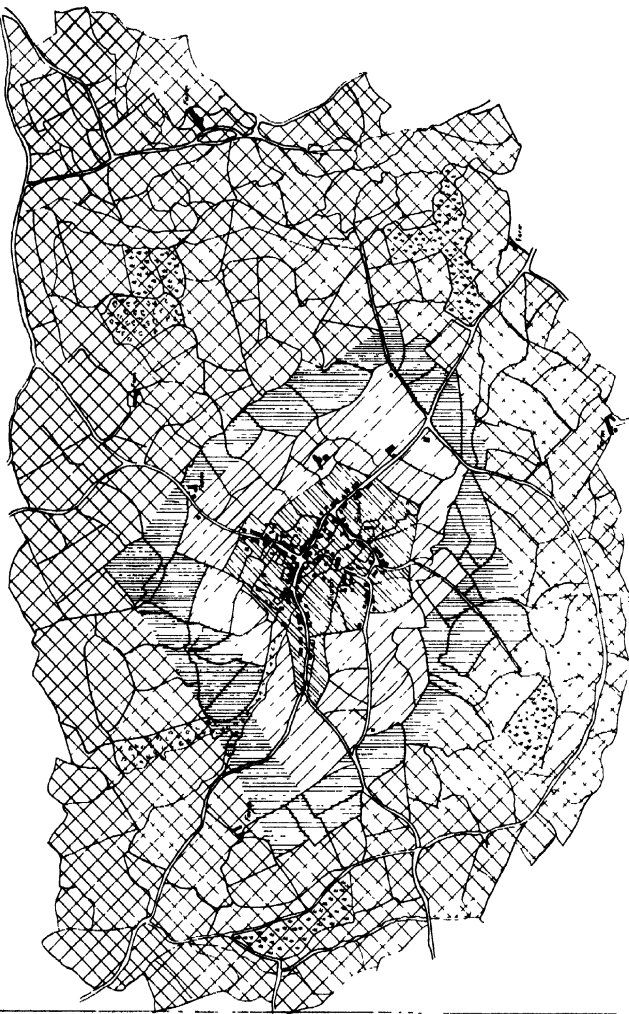


Figs. 16 and 17 Rear view of a pair of cottages before and after reconditioning



FIG. 18 Front view of the same cottage

EXTRACT FROM REGIONAL MAP SHEWING RURAL ZONING



AREA SUBJECT TO ISSUE OF
GENERAL DEVELOPMENT ORDER
i.e. UNZONED LAND TO BE
RELEASED FOR DEVELOPMENT AT
DISCRETION OF LOCAL AUTHORITY.

CORE OR BUILT-UP AREA

AREA SUBJECT TO DENSITY
e.g. 4 6 OR 8 HOUSES PER ACRE

RURAL ZONE

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whether or not the dwelling changes hands in the meantime. Where the grant is refunded, a Certificate is given by the Clerk to the Local Authority to the effect that the conditions ceased as from the date of repayment.

Solution of the Problem. It can be reasonably anticipated that the facilities which have been outlined in this article will have an appreciable effect in alleviating the housing shortage in rural areas and will do much to promote the well-being and efficiency of agricultural workers. The beneficial effect on the health of the worker and his family cannot be overestimated, and the convenience of having cottages exactly where they are needed is obviously a great boon to the employer of agricultural labour.

It will not do for the owner of unsatisfactory cottages to ignore the fact that in addition to their powers of providing houses Local Authorities are also invested with considerable statutory power to prevent the occupation of houses which are unfit for human habitation. Under Section 11 of the Housing Act of 1936, Local Authorities may order the demolition of a house which is occupied, or is of a type suitable for occupation by persons of the working class, if they are satisfied that the house is unfit for human habitation and is not capable economically of being rendered so fit.

Before definite action is taken under this particular measure, however, the owner is reminded of the provisions of the Rural Workers Acts and given the opportunity of submitting to the Local Authority within a specified time proposals for improving the houses, but unless these are accepted, or, if accepted, the improvements are not carried out within a stated time, the Authority is bound to make a demolition order, requiring the house to be vacated and subsequently demolished at the owner's expense.

Having in mind all the publicity which has been given to the Rural Workers Acts in recent years, the generous State assistance available towards reconditioning or building new cottages and the vigorous drive which Local Authorities are making against "slum" conditions and overcrowding, the time is not so far distant when the labourer will be attracted to, rather than driven from, the English countryside.

FEEDING STANDARDS FOR FARM ANIMALS : IV. THE QUALITY OF PROTEIN

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Last month's article dealt with the *quantity* of protein which must be included in the rations of farm animals in order to meet their requirements for maintenance, growth, fattening, and milk production. In the present article detailed consideration will be given to the influence of protein *quality* on the nutritional requirements of the various classes of live stock.

Biological Values. It has long been customary in formulating human dietaries to differentiate between the total protein requirement and the requirement of "first-class" protein. This differentiation is based on the results of numerous accurately controlled feeding experiments—usually carried out with rats as experimental subjects—which have shown that proteins derived from different sources vary in their ability to provide for the maintenance and growth of the body tissues. Thus it has been found that animal proteins, such as those of milk, eggs and meat, are, in general, superior in nutritive value to vegetable proteins, such as those derived from cereals and legumes. In quantitative terms the former have biological values* of from 70-90 per cent. while the biological values of the latter usually fall between 40-70 per cent.

Until quite recently no serious attempt had been made to introduce any similar conception in formulating protein feeding standards for farm animals. This is probably attributable to two facts: first, to legitimate doubts as to whether results obtained with one species (e.g., rats) can be arbitrarily applied to another (e.g., sheep or pigs); and second, to the technical difficulties and high costs involved in carrying out the necessary feeding experiments with the larger farm animals.

As regards the first point, it would seem reasonable to suppose that the requirements of all omnivorous species would be substantially identical, and that results obtained in rat-

* The biological value may be defined as the percentage of the digested protein utilized by the body. In reality it constitutes a measure of the efficiency with which the digested protein supplies the amino-acids required for the construction of the proteins of the body tissues or (with lactating animals) of the milk proteins.

feeding experiments (on which most biological values are at present based) could therefore be justifiably applied to pigs. It would, however, still only be possible to arrive at very approximate biological values for the various foods in common use, since widely different results have been reported in the literature. Thus wheat proteins have been given values ranging from 47-61 per cent., maize proteins from 54-67 per cent., and milk proteins from 51-86 per cent. As regards the second point, i.e., the difficulty and cost of carrying out experiments on protein quality with farm animals, it is somewhat surprising that so few trials have been carried out with pigs, particularly in view of the fact that their rapid rate of live-weight increase would make them ideal subjects for such studies. Swine-feeding experiments at Wisconsin, Illinois and Purdue have, however, confirmed in general the results obtained with rats, and have once more demonstrated the marked superiority of most forms of animal protein over proteins of vegetable origin. Thus it has been clearly shown that the substitution of either skim milk, fish meal or meat meal increases the biological value of the proteins of typical cereal rations, whereas linseed and cottonseed meals fail to do so. The advantage of including from 10-20 per cent. of animal protein in the rations of pigs is, indeed, already recognized by many practical breeders in this country.

Turning to sheep and cattle, the position is complicated by the doubt as to whether figures obtained in experiments on omnivorous species can be applied to ruminants. Ruminant digestion involves extensive bacterial multiplication, and it has been suggested that, as a result of the possible breakdown of the ingested protein and its subsequent re-building into bacterial protein, the biological value of the original ration may be materially altered. Moreover, the investigator is faced with a second difficulty in attempting to apply the results of rat-feeding experiments to ruminants, since a large proportion of the rations of the latter consists of bulky and fibrous fodders which cannot conveniently be fed to small experimental animals. A still further complication is encountered in dealing with the requirements of dairy cows, since one is then attempting to measure the biological value of the food protein for a separate function, i.e., milk production, although alterations in the body tissues may be taking place simultaneously. In spite of these difficulties it has been found possible during

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the past few years not only to show that the conception of biological values is applicable to ruminants as well as to non-ruminants, but to provide approximate quantitative information regarding the biological values of a number of typical rations. Maynard and his co-workers at Cornell have, for example, shown the superiority of soya-bean meal over maize-gluten meal for the growth of sheep. Morris and Wright have demonstrated in experiments at the Hannah Institute the relatively low biological value of wheat gluten in comparison with either blood meal, maize germ meal or rye, when these foods are used as the basis of the maintenance rations for steers. Hart and Humphrey of Wisconsin have shown the superiority of the proteins of milk powder and of certain oil seeds over those of maize and wheat for milk production. The Hannah Institute workers have also carried out extensive investigations into the biological values of various proteins for milk production. Using high-yielding Ayrshire cows, they have been able to assign approximate biological values to the protein mixtures contained in a wide variety of rations. Thus they found that the highest values (ranging from 75-80 per cent.) were given by rations containing either dried blood meal or fresh, dried or ensiled spring grass, intermediate values (between 55-65 per cent.) by rations containing either pea or bean meal, fresh or dried autumn herbage or meat meal, and the lowest values (from 45-55 per cent.) by rations containing either earth-nut cake, linseed cake or maize products. One interesting observation made by these workers was that animals fed on the poor quality proteins showed a definitely higher percentage digestibility of the food protein—a fact which might be looked upon as an involuntary effort on the part of the animal to “squeeze out” all possible nutrient value from the ingested material. It is also interesting and perhaps significant to note that, so far as milk production is concerned, the right value of bean meal and the superiority of spring over autumn herbage have long been recognized by practical breeders, though the reasons for the observed differences in nutritive value had not hitherto been clear.

Supplementary Relation of the Proteins. It will be seen that our knowledge of the relative biological values of the proteins of the commonly used feeding stuffs is still somewhat fragmentary. Moreover available evidence relates chiefly to mixtures of feeding stuffs and not to the individual con-

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stituents. This is due to the fact that it is impracticable to feed the individual constituents of a ration separately, owing to the necessity for maintaining a proper balance between the energy and protein content and for providing a sufficient supply of roughage to enable digestion to proceed normally. *It would, however, in any event, be of little practical value to determine the biological values of individual feeding stuffs, since it has been found that the biological value of a mixed ration is not necessarily that of its components.* Mitchell has shown, for instance, that while the biological value of maize is 54 per cent., and that of poor quality slaughter-house offals is 42 per cent., the value of the two combined is 61 per cent. Similarly a ration consisting of milk proteins and maize showed a markedly higher biological value than would have been expected from the mean value of the two. Again, Morris and Wright found that, whereas the proteins of ossein (bone protein) and decorticated earth-nut cake had low biological values and consequently failed to maintain milk yield when fed separately at a border-line level, a ration containing a combination of these two proteins was adequate to permit normal milk secretion. This phenomenon is assumed to be due to the fact that, whereas the proteins of each separate food may be deficient in one or more essential amino-acids,* the two together supplement one another and provide a protein mixture containing adequate proportions of all essential amino-acids. For example, ossein is known to be rich in lysine and poor in tryptophane, while the proteins of earth-nut cake are rich in tryptophane and poor in lysine. A mixture of the two will, however, contain adequate quantities of both these essential amino-acids.✓

It might be anticipated that this supplementary relationship would not only exist between the proteins of the various constituents of the production ration, but that there would be a similar supplementary relationship between the proteins of the production ration and those of the maintenance ration. This has, in fact, been demonstrated in some very recent work by Morris and Ray, who have shown that the substitution of

* The amino-acids, which form the "building stones" of all proteins, can be classed into two groups. One, the so-called non-essential amino-acids, can be synthesised in the animal body from simpler nitrogenous materials; the other, known as essential amino-acids, cannot be synthesised in the animal body, and must therefore be derived directly from the food. Among the latter the most important in animal nutrition are probably lysine, tryptophane, cystine, and arginine and histidine.

FEEDING STANDARDS FOR FARM ANIMALS

good quality hay for straw in the maintenance ration of milking cows enabled milk secretion to continue at a satisfactory level, in spite of the fact that a poor quality production ration was fed.

Practical Implications. From the point of view of the practical rationing of farm animals the important question is, however, *whether existing protein requirements can be quantitatively adjusted to allow for differences in protein quality.* In view of the supplementary action which one protein may exert on another it does not seem possible to devise a system based simply on the biological values of individual feeding stuffs. An alternative method has been suggested by the Hannah Institute workers. These workers have found that a very close parallelism exists between the biological values of various proteins and their relative proportions of the essential amino-acid, lysine. On the assumption that a deficiency of lysine is the most usual cause of the lowered biological values of poor quality proteins, these workers have proposed that rationing tables should, in addition to laying down the total protein requirements of stock, include standard lysine requirements. This method of computation would, of course, avoid the difficulties inherent in the direct use of biological values. On the other hand, the method has certain drawbacks: In the first place it is entirely dependent on the accuracy with which amino-acid analyses can be carried out on whole feeding stuffs. Differences of opinion exist regarding the relative accuracy of the methods of analysis at present available, and until these are resolved it would seem premature to advocate the widespread adoption of any new standard. In the second place, while it is true that the poor quality of certain proteins appears to be most commonly associated with a deficiency of lysine, other amino-acid deficiencies (such as a deficiency of tryptophane) are also known to exist, and these would obviously not be allowed for in the suggested standard. In the third place, it is questionable whether it would in any event be wise to introduce at this stage any additional calculations in computing rations for live stock. It is true that the suggested standard lysine requirement has been used in practice by a number of progressive firms who market composite feeding stuffs, with, it is understood, most promising results. As regards individual breeders it is, however, already difficult to ensure the use of even the present relatively simple protein feeding standards, and any attempt to add further

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refinements to these standards would therefore be of very questionable value. It would seem that the best procedure to adopt meantime would be to stress the differences in quality which exist between proteins derived from different sources, and to advise the breeder in general terms to select a reasonable proportion of the constituents of his rations (say at least 10-20 per cent.) from those feeding stuffs which are known to possess high biological values. Among these may be mentioned low temperature dried blood meal, fish and meat meals, young grass (either fresh, dried or ensiled) and leguminous crops such as peas, beans and soya beans. *It is significant to note that most of these feeding stuffs can be produced either on the farm or as by-products of existing home industries.*

In last month's article it was pointed out that existing feeding standards for growth are based on an assumed utilization of protein of only 33-40 per cent., and it was suggested that these standards might supply too generous an allowance of protein. Figures which have been quoted in the present article show that the minimum biological value recorded for any individual feeding stuff is about 40 per cent., while values for mixed rations are usually over 50 per cent., and often much higher. It seems clear, therefore, that the existing protein standards for growth could justifiably be reduced, particularly when the bulk of the ration is drawn from foods containing proteins of relatively high biological value. On the other hand the protein standards for milk production assume a utilization of protein of roughly 60 per cent. This is definitely on the borderline level and justifies the recommendation that, when protein concentrates are cheap, a more liberal standard should be adopted.

Effect of Processing on Protein Quality. In considering protein quality one further question arises, i.e., the extent to which manufacturing processes (such as extraction, cooking and drying) are likely to affect the biological value of the proteins of feeding stuffs. As regards animal products there is evidence that the biological value of casein is reduced by excessive heating, while the "browning" of dried milk powder also adversely affects the quality of the milk proteins. Fish meals can apparently be dried at 200°C. without detrimental effect, but higher temperatures (up to 600°C.) reduce the biological value of the proteins. The same appears to be true for meat meal and other similar slaughter-house by-

FEEDING STANDARDS FOR FARM ANIMALS

products. As regards all such by-products it must, however, be borne in mind that, apart from any specific effect of processing, the quality of the protein will depend very largely on the type of offals used. Thus the inclusion of a large proportion of the proteins of bone and connective tissue will inevitably result in the production of a meat meal of poor biological value.

The biological value of the proteins of blood meal is also greatly affected by the treatment to which the blood is subjected. The proteins of blood which has been allowed to deteriorate during the interval between collection and treatment and which has subsequently been dried at a relatively high temperature will have a disappointingly low biological value. For the production of blood meal of the highest quality, the blood should be used fresh and should be dried at a temperature not exceeding 100°C.

As regards vegetable proteins, there is no conclusive evidence as to the effect of "cooking" on such cereals as wheat and maize, though it seems clear that the process does not adversely affect the biological value of the proteins. There is, indeed, evidence that the autoclaving of soya beans actually increases their biological value. Excessive heating, such as takes place on the crust of a baked loaf, lowers the biological value. On the other hand recent experiments have shown that the conservation of young grass by artificial drying has no such adverse effect. This has not only been demonstrated in rat-feeding experiments, but has been confirmed in experiments designed to determine the effect of high drying temperatures on the biological value of grass proteins for milking stock. In the latter investigation the time and temperature of heating (350°C. for 20 minutes) was sufficiently high to produce visible scorching, yet no reduction in biological value was observed. It might, incidentally, be noted that grass conserved by ensiling, either with the addition of molasses or of mineral acid mixtures, gave a biological value as high as that of the freshly cut herbage.

It appears, therefore, that, while animal proteins are in general somewhat susceptible to heat treatment and may possess variable biological values according to the methods employed in their manufacture, vegetable proteins are less susceptible to processing and are likely to show comparatively small variations in protein quality even when they are subjected to fairly drastic heat treatment.

THE PLUM PLANTATIONS OF WORCESTERSHIRE

E. W. HOBBIS

Plum growing in Worcestershire, to the majority of people, is inseparably connected with Evesham and Pershore, and it is a common error to suppose that production in these two areas typifies plum growing throughout the West Midlands. True, commercial production was pioneered in and around Evesham and Pershore, but plantations have sprung up since in most parts of Worcestershire and in many places have overflowed beyond the county borders. Production is still mainly concentrated in the Vale of Evesham and around Pershore, but considerable acreages, many of them highly farmed, are established in the vicinity of Worcester, Malvern, the Teme Valley, Stourport, Holt, Hartlebury, Bewdley and Bromsgrove.

According to statistical returns,* Worcestershire grows about 9,809 acres of plums out of a total area of orchard fruits which exceeds 25,000 acres. In point of acreage, Worcestershire is only second to Kent in the production of plums.

The foundation of Evesham's importance as a fruit and market-gardening centre was undoubtedly laid some hundreds of years ago, following the establishment of a Benedictine Monastery there about A.D. 709. The skill of the Benedictines as cultivators of the soil was phenomenal, and doubtless their influence resulted in the growth around them of a community highly skilled in husbandry. This background forms a tradition inherent in the Evesham growers of to-day—it might be truly said they are "born cultivators of the soil." The plum was probably grown in the early days and certainly in later years, but it was not until round 1880 that a real expansion of plum-growing on a commercial basis took place.

Soils. The soils of the plum-growing areas vary considerably. In the Evesham and Pershore areas the finest trees are found on heavy clays of Lower Lias origin. The carbonate of lime content of these clays is often high, and because of this drainage is satisfactory and the soils are genial to tree growth.

Good trees are also found on heavy loams derived from glacial or river drift with satisfactory drainage. Shallow loams and sands occur in these districts on which develop-

* Agricultural Statistics, 1937.

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ment is poor, and where drainage is impeded tree growth is highly unsatisfactory.

Around Worcester, plantations occur on medium to heavy loams derived from Keuper Marl; the soils are, in the main, calcareous and although drainage is slow, plums usually grow into satisfactory trees. Where these soils are overlaid with Bunter Sand and gravel, non-calcareous in character, drainage is frequently impeded near the base of the surface deposit, when trees fail to make good growth.

Plantations in the Teme valley are mostly on heavy and medium loams derived from Old Red Sandstone; the soils are generally non-calcareous, but drainage is fairly free and tree growth good.

Around Kidderminster, Stourport and north-west of Bromsgrove, plums are grown on light sandy soils derived from Keuper and Bunter Sandstone, and success here is largely bound up with sufficient moisture and an adequate supply of potash.

East of Bromsgrove some plantations are on similar light sandy soils, but others are on heavy loams derived from Keuper Marl, and trees attain a good size.

The rainfall of the county graduates from 26.67 in. per annum in the southern area, to a slightly higher amount through the centre portion, and finally reaches 29.77 in. in the northern area. Summer moisture supply is particularly important for plum fruit development, and the successful growing of trees and crops on the light soils in the northern part of the county is probably influenced by reason of the higher rainfall.

Established Evesham Plantations. Practically all of the earlier Evesham plantings were made by small holders who seldom rented more than about 5 acres of land, and it is still not uncommon for the total acreage to be made up of several smaller parcels of land in separate villages. From the beginning, the growing of plums was undertaken in conjunction with market gardening, and the usual policy was to plant trees closely in rows which might be 22 yards or more apart. The land between was cropped with vegetables, such as peas, beans, spring onions, cabbage, sprouts, etc. Manuring was of a very high order, particularly as regards nitrogen, and a high state of fertility was maintained, which resulted in plum trees of good size and cropping capacity. This method of establishment from the fertility viewpoint may be compared

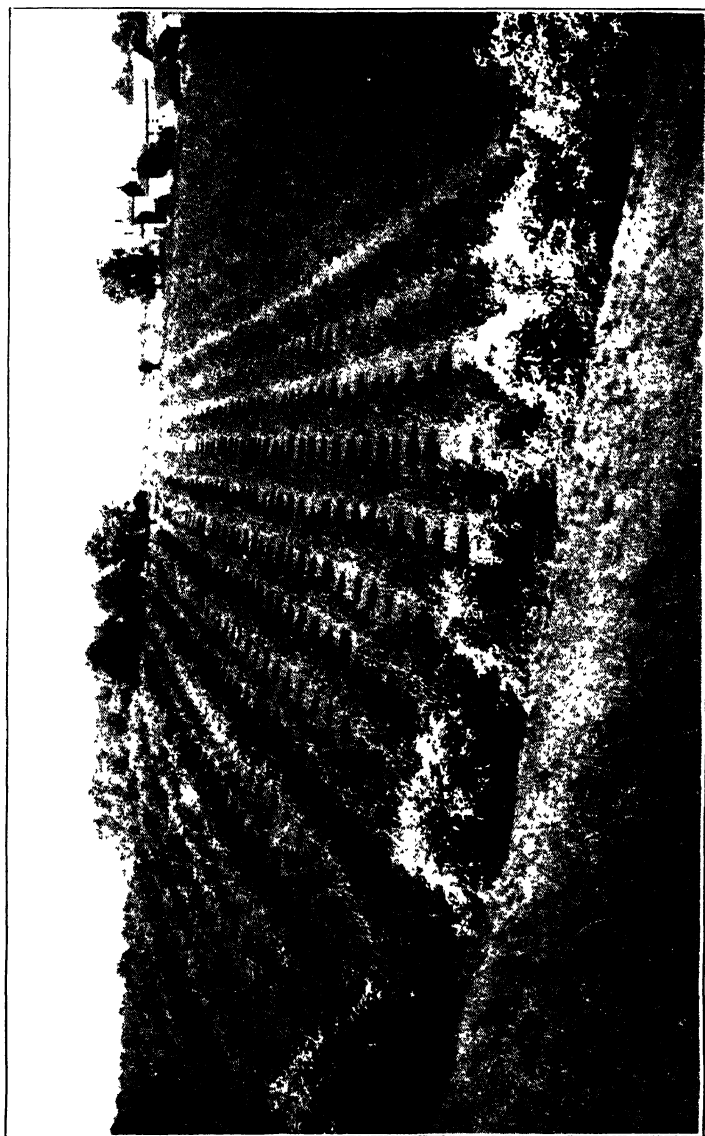


Fig. 1 A well planned and well spaced plum plantation in Worcestershire
Photograph Copyright by Long Ashton Research Station



FIG. 2 - 10-year-old Victoria Plum on Pershore Yellow

Persea glabra Copey 4-10 Long Ashton Research Station
A well grown tree on heavy soil

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with the Kent practice of planting young cherry trees in hop-gardens a few years before the latter were due to be grubbed.

Numerous small plantings were also made by men who cultivated a holding during their spare time, and a frequent practice in such instances was to plant trees in random fashion, with no set plan, distance or number of trees per acre. Every inch of ground beneath the trees was cropped and cultivated by hand and this, coupled with the facts that manuring was rarely of a sufficient standard and trees were greatly overcrowded, resulted in plantations which quickly aged and became useless.

On this type of holding, Pershore Yellow (Egg Plum) was planted almost exclusively, largely by reason of the fact that the variety grew true from suckers and thus provided cheap and readily available material for planting.

The foregoing systems have been largely superseded, due chiefly to the difficulty of reconciling vegetable-growing with tar-oil winter washing, which has become a vital routine in any attempt to produce regular and heavy crops. Hand labour has risen in cost, and this also has influenced the system of growing, with the result that plums, previously considered an essential crop in the smallest holding, are less grown by small holders and are being produced more and more by the larger growers. The small grower has turned his attention increasingly to more intensive cultures, and the newer plum plantations are being established as large-scale plantings outside the older congested areas.

Newer Plantings near Evesham. Many acres of plums have been planted in recent years by established Evesham growers and also by comparative newcomers to the industry.

They have studied the errors revealed in the old plantations and have concentrated on few and better varieties, which are being grown on soils on which tree growth flourishes. Spring frost "pocket" areas have been shunned, and in many instances some provision has been made for cross-pollination. Production has, therefore, been set up under better initial conditions in outlying districts, as in the extensive Lenches Country and on high land round Craycombe Hill and Harvington.

Plums in the newer areas are treated as a specialized crop. Ample spacing is allowed between the trees, 16-18 ft. being common. Little or no undercropping is done and high manuring, coupled with thorough cultivation, results in fast-

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growing, potentially heavy-cropping trees, with the prospect of a lengthy fruiting life.

Whereas many of the old plantations of Evesham still suffer from defective pest and disease control, methods being out of date and machinery antiquated, the newer plantations are invariably winter washed with tar oil and petroleum to control aphid and red spider, and summer washing to control red spider and plum sawfly is being better understood.

Production in Other Areas. Plum growing around Worcester, in the Teme Valley and in the Ombersley area is mostly in the hands of large growers who frequently combine blackcurrant, and sometimes gooseberry growing with that of plums. The undercrop is dispensed with when cultivation becomes difficult due to the spread of the trees.

There is no recognized spacing for trees in such plantations, but examples met with include trees at 16 ft. intervals with 1 row of soft fruit bushes between, or 18 ft. intervals with 2 rows of bushes between. One or two grass plantations exist, but they are exceptions.

Production in the area immediately around Bromsgrove is mainly in the hands of small to medium growers who undercrop with both soft fruits and vegetables.

Damson production in Worcestershire is concentrated along the Teme Valley, mostly on the higher slopes, on high land round Bewdley, and to a lesser extent between Inkberrow and the Lenches.

Varieties. A catalogue of plum varieties found in the county would be of considerable length. In point of acreage, prominence must be given to the Pershore Yellow, more generally spoken of as the Egg Plum. The variety is a rapid grower, a prodigious cropper and the fruit can be picked over an extended period, early green pickings being consigned to jam manufacturers, and later pickings being sold on the fresh-fruit markets. Although mainly planted in and around Evesham and Pershore, its cultivation has become general throughout the county.

In 1936, the Long Ashton Research Station made a detailed survey of fruit-growing and market-gardening in the Vale of Evesham, and in connexion with this survey an estimate was arrived at of the relative number of plums of each variety grown. The Pershore Yellow, being predominant, was made the basis of comparison and allotted the number 10. Other varieties compared as follows:—

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Pershire Yellow	10	Giant Prune	2
Pershire Purple	8	Evesham Wonder	2
Victoria	7	Pond's Seedling	2
Czar	5	Warwickshire Drooper	2
River's Early Prolific	4	Damascene and Damson	1
Belle de Louvain	3	Other Varieties	
Monarch	3		less than 1

The first five varieties in the foregoing list accounted for two-thirds of the total area of plums in the district.

The newer plum plantations elsewhere in the county would produce a much modified list, and in many places the position in respect of varietal popularity would also change.

Pershire Yellow would seem to be produced in sufficient quantity to meet demand, and for this and other reasons the variety has lost much favour. Few plantings have taken place in recent years and many acres of old plantations have been grubbed.

Extensive plantings of Pershire Purple have been made in recent years and the variety is predominant on some farms, but here again many growers are turning to other sorts for present-day planting.

It should be stated, however, that new areas of both of these varieties have been established recently by growers who believe that by careful cultural management, high nutrition and good pest and disease control, a superior grade of fruit can be produced in quantity at lessened cost.

The variety Victoria holds a strong position and is probably planted in greater quantity than any other variety to-day.

Amongst the "other varieties" mention can be made of Evesham Wonder, Prince of Wales, Coe's Late Red, Curlew, Heron and Wyedale, whilst the only Damson in favour is the Shropshire Prune.

If Victoria be excluded, little attempt has been made to satisfy market demand for dessert plums and gages, although a few isolated rows of Early Transparent Gage, Oullin's Golden Gage and Denniston's Superb occur in scattered plantations. Dessert plums meet a ready sale in this country and present supplies are almost wholly imported. Growers might do well, therefore, to study the possibilities of dessert-plum production when contemplating any expansion of acreage under this fruit.

Present-day plantings in the county might be listed with reasonable accuracy in the following order:—Victoria, Giant

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Prune, Pershore Purple, Monarch, Pershore Yellow, Belle de Louvain, Bountiful and Early Laxton.

Although the planting of Giant Prune persists, some growers are alarmed at the serious losses sometimes occasioned by bacterial die-back to which the variety seems very susceptible. In this connexion it is widely held that a degree of resistance is obtained by working the variety "high" on Pershore Yellow as the rootstock.

It might be well to mention here that some confusion exists in the correct naming of the variety in question, which is variously called "Giant Prune," "Burbank's," and "Burbank's Giant Prune." The variety quoted here is that referred to as "Giant" in Hedrick's *Plums of New York*, and belongs to the *P. domestica* group. Burbank is a distinct variety belonging to the *P. triflora* group. The introducer of both varieties, however, was Luther Burbank, and herein lies the reason for the confusion.

Nursery Practice. Some growers maintain well-run tree nurseries on their own farms, but as a contrast one frequently sees trees being raised by the roughest of methods on odd corners of ground. Suckers, reputedly Pershore Yellow, but on occasion of mixed character, are planted out for working to other varieties as and when required, and those which grow too large for grafting are merely shaped up and planted out as Pershore Yellow on its own roots.

Grafting, as opposed to budding, is practised almost exclusively. The method generally adopted is that of a "Saddle," and skilled grafters are in much demand in the working season. Top-working is not a general practice, but in recent years many acres of established Pershore Yellow have been worked to more profitable sorts.

Trees for many of the newer plantings in the county have been obtained from outside nurseries, and these are worked variously on Myrobolan, Common Plum, Brompton and Mussel. The type of tree raised is almost exclusively the half-standard with a leg of about 4 ft.-4 ft. 6 in. long, and most trees are worked on Pershore Yellow. This rootstock has proved itself over many years. Provided the true stock is used, highly satisfactory trees are obtained and there seems little evidence of incompatibility with any of the commercially grown varieties.

Plantation Management: Cultural Practices and Manuring.

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An indication has been given previously of the type of plantation found in various parts of the county. Clean cultivation is a feature in common almost everywhere, in some measure due to the fact that Pershore Yellow as a rootstock demands arable conditions as opposed to permanent grass, trees in the latter rarely attaining any great size or age. On many holdings in the Vale of Evesham clean cultivation is carried on to the point of total suppression of weed throughout the year; vegetable crops grown beneath the trees are sold off the holding and farmyard manure of any kind is rarely applied. Many acres of trees, therefore, have been established under conditions where humus is constantly depleted from the soil. In some instances the organic matter has fallen so low as to bring about a complete standstill condition of the trees which fail to respond to any form of inorganic manuring.

Where trees cover the whole ground—many growers have discontinued any form of undercropping—a good tilth is maintained in spring and early summer to encourage tree growth, and autumn weeds are allowed to grow to be turned in during the winter. In this way soil texture and the content of humus are preserved in some measure; similarly, the use of organic manures such as shoddy, hoof and horn meal, fish meal, etc., are favoured in preference to quick-acting fertilizers for maintaining the nitrogen supply.

Green manuring is rarely practised; no plantations are sod-mulched and very few exist as orchards in grass excepting when the trees are intermixed with apples.

In the market-gardens, plums are often considered of secondary importance to vegetable crops and the care expended on them is proportionate. Where undercropping is practised with blackcurrants, the high feeding for the one fruit is well suited to the other and, where ample space has been allowed, tree development is usually rapid.

It would seem, however, that the most successful plum-growers at present, and those who will best weather the future, are those who plant wide and grow no undercrop. Flexibility of soil management, easy access for spraying, picking, etc., are obtained and cultivation costs can be reduced to a minimum.

Plums pay for high manuring, and this is clearly demonstrated in all parts of the county. Trees must refurnish themselves with new wood every year if a heavy cropping capacity is to be maintained. Further, as a result of a detailed survey

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of certain plum plantations in Worcestershire in 1938,* there seemed sufficient evidence to state that high manuring, coupled with high cultural conditions, could reduce the ravages of spring frost in a plantation to an appreciable degree.

No scheme of manuring representative of general practice in the county can be given. Dung is rarely used. Custom in the Vale of Evesham and around Pershore still favours the use of organic fertilizers, such as shoddy and hoof and horn, supplemented by fairly regular dressings of phosphates and, less often, of potash. Soot enjoys a high reputation, especially on the heavy soils, where its beneficial effect on soil tilth as well as its stimulating effect on the trees is widely appreciated.

In the other areas, the use of organic fertilizers, with perhaps the exception of fish meal, is not so common. Sulphate of ammonia and nitro-chalk are the usual sources of nitrogen supply and sulphate of potash is more regularly used, phosphates being applied less frequently.

Pruning. From 2- to 4-year-old trees are usually used for new plantings. Pruning is generally withheld until the following year when cutting is hard.

The hardest pruning of young trees is practised in and around Evesham and Pershore, where it is not uncommon to see trees hard pruned for 5 or 6 years to obtain a shapely head. Aftercare, however, merely involves the removal of dead and broken limbs. Most of the other areas in the county favour a much lighter pruning after the early years, one or two hard cuttings being considered sufficient, except with Victoria, before allowing the tree to develop freely.

Crops. Plums are notoriously erratic in cropping although this tendency has been modified to some extent by the control of aphids by tar-oil winter washing. Spring frosts all too frequently reduce or ruin crops and the high winds so often experienced during late April cause considerable damage to the swelling fruitlets. Given a reasonable degree of freedom from spring frosts, however, and a management aimed at producing an ample amount of new wood each season, the unevenness of cropping can be levelled out to some extent.

Yields per acre vary enormously, not only from year to year, but also according to variety and, of course, age of tree. Few sorts, for example, have the enormous cropping

* *Worcs. Agric. Quarterly Chronicle*, Vol. 7, No. 1, Nov., 1938.

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capacity of Pershore Yellow, or, in a better class, the excellent dual-purpose plum Victoria. In the Evesham area, 200 pots* (a little over 6 tons) is considered a good crop per acre on a fully established plantation. On occasion, however, Pershore Yellow has doubled this figure, not only in Evesham but in other growing areas of the county. An approximate estimate of yield per acre over a series of years, based on the several varieties commonly grown, would be from 3 to 4 tons. Good management and favourable situation may easily increase this figure, but many plantations exist which produce lower yields. Branch propping is a common practice on most varieties during the fruiting season throughout the county. The usual method is to prop with forked poles, several being set to each tree. The "maypole" method, whereby one stout pole reaching above the branches is secured to the trunk of the tree and to which branches are tied by cord, is frequently seen and a few farms adopt a roughly rectangular frame of poles secured on corner posts, the branches thus hanging over the sides of the frame. Propping calls for much skill and practice and if improperly done it may lead to unnecessary limb breakage instead of preventing the trouble.

The cropping life of a plum tree is governed by numerous factors. Generally speaking, fruiting of any worth may begin any time after the fourth year, the trees being in prime fruiting condition from the tenth to the thirtieth year. Records exist of trees 70 and more years of age continuing to fruit, but the crops they would produce would rarely be of a high commercial standard.

Picking by piece-work, except for Pershore Yellow and other plums picked for jamming or pulping, is less common than formerly. Average rates for piece-work vary with crop weight and variety. A figure for Pershore Yellow is about 8d. per pot, for Victoria a 1s., and for the general run of varieties 10d. per pot.

Picking by hourly rates has become more common in recent years, due largely to the demand for better quality samples on the markets. In this connexion the rapid changeover from returnable wicker pots, except for jam plums, has been remarkable, and much selective picking is now done by carefully supervised labour picking direct into the chip basket container.

* A pot is 72 lb.

FARM WATER SUPPLIES

A. G. CARSWELL,
Siddington, Cheshire

Water supply has always been one of the difficult problems of the farming industry, and there is no necessity to emphasize how vitally important is the provision of an adequate and reliable supply to the homestead and pastures for the successful running of a farm. The demand for Accredited Milk Licences has made this subject still more vital and urgent. The health and well-being of all stock* are seriously affected by the lack of free access to water, and much of the trouble from disease is attributable to badly constructed drinking places, particularly open ponds.

One of the best investments on a dairy or mixed farm is the installation of an adequate water supply; the return on the expenditure will be shown both in the milk yield and the general health and condition of the stock. A further saving will be shown on mixed farms in that a smaller area of succulent crops is required for the cattle during winter, and an additional area can consequently be put under other crops.

Quantity of Water Required. The following quantities should be allowed per day on a farm producing accredited milk :—

Milking Cows	..	20 gal. per head
Other Horned Stock	10	" " "
Horses	..	10 " " "
Pigs	..	2 " " "
For Cooling and Dairy	3	" for each gal. of milk refrigerated.

On a typical mixed dairy farm of 100 acres this will mean :—

35 Milking Cows	at	20 gal.	..	..	700 gal.
15 young stock	at	10 "	..	..	150 "
3 Horses	at	10 "	..	..	30 "
30 Pigs	at	2 "	..	..	60 "
Dairy of 70 gal.	at	3 "	..	..	210 "
Farm house	at	150 "	..	..	150 "
Farm cottage	at	50 "	..	..	50 "
Total					<hr/> 1,350 " <hr/>

or say 13½ gal. per acre, per day.

* See *The Water Needs of Live Stock*. This JOURNAL, October, 1938, pp. 653-659.

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If this quantity is used from a public supply at a cost of 1s. 6d. per thousand gallons, it will cost approximately £37 per annum or about 7s. 6d. per acre per annum.

With care it may be possible to manage with a much smaller quantity—possibly half if use is made of any available drinking places on the farm for young and dry stock, and water used for cooling is conserved.

Eight small holdings in Cheshire, averaging 47 acres each and with 22 milking cows per holding, all obtain their supply from public companies at a charge of 1s. 6d. per 1,000 gal. Their average charge per annum is 3s. 2d. per acre, which shows that they manage on an average of 6 gal. per acre, per day.

Sources of Supply. In addition to the public supply, the use of which may or may not be economical, there are various other sources which can be classified as follows:—

- Natural springs.
- Streams.
- Water in land drains fed by springs.
- Ponds fed by springs.
- Shallow wells.
- Deep wells.

By adopting satisfactory methods of collection, the yield of a spring or from land drains may often be found to be much more than at first appears. In the event of one being so fortunate as to have several sources of supply available, such factors as the reliability of the supply, proximity to the point where the water is required and the adaptability of the supply to the most economical water-raising plant, should influence the decision regarding the source to be used.

Before deciding to use an existing well, the yield should be tested by pumping over a period of several days, the flow being measured, as it is a common mistake to assume that because the well has always met normal requirements and never been dry, it will meet the strain of the increased demand made by the continual pumping of several times that quantity per day.

Supply System. There are six means of getting the water to the storage point of the homestead:—

- Gravitation.
- Hydraulic Ram.
- Windmill Pump.
- Water Wheel Pump.
- Engine Pump.
- Electric Pump.

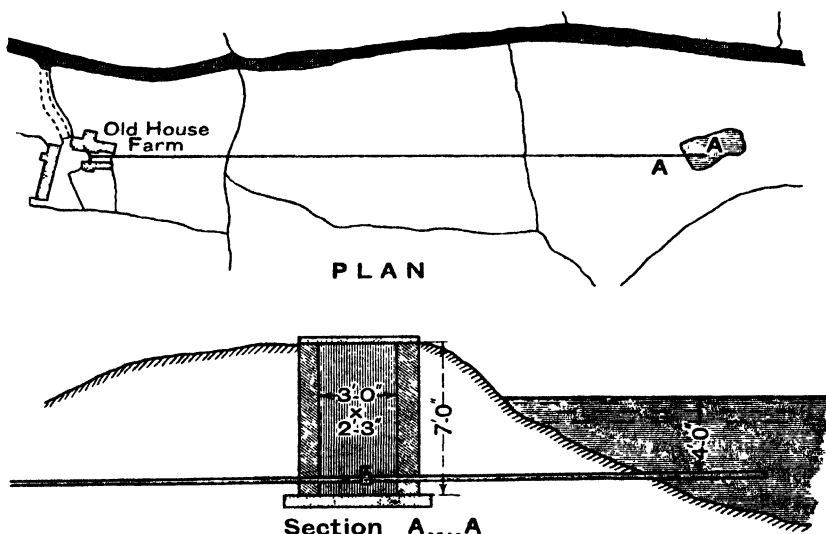
FARM WATER SUPPLIES

GRAVITATION. If the source of water supply is at a higher level than the points it is desired to serve, it is, of course, fairly obvious that a supply by gravitation should be the best and cheapest.

If the supply is from a spring-fed pond at a height sufficient to feed the homestead by gravitation, it is advisable to put the draw-off pipe 2-4 ft. below the water level to ensure a supply in the event of a fall in level, and also for cooling purposes, to obtain cold water not affected by sun.

The site of the pond will probably be in clay or marl. A small chamber should be built as near as possible to the pond in which to fix a valve to control the supply. From the excavation for this chamber and by excavating a portion of trench, the last length of pipe can be bored into the pond. The method I usually adopt is to saw-tooth a short length of the pipe to be used, drive this in with a wooden mawl and withdraw it to clean it out, adding short lengths as required. When boring the last two or three feet, the pipe is not withdrawn and the valve is fixed on, then the core is pushed through into the pit with drain rods.

The sketch below is of a supply by gravitation where this method was adopted :



FARM WATER SUPPLIES

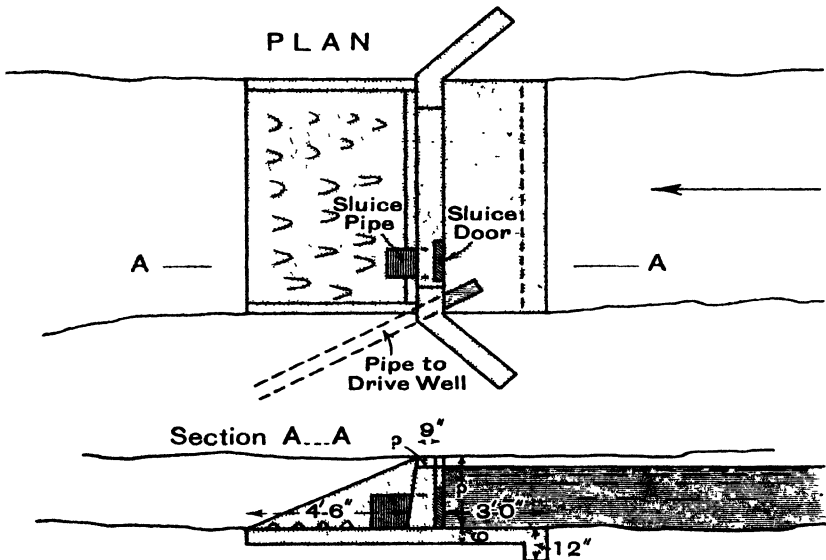
Spring-fed drains sufficiently high above the homestead may sometimes be used by building a small collecting chamber and piping from this to the buildings or field drinks. If the quality of the water is not suitable for human consumption, it may possibly be quite fit for stock and cooling purposes.

HYDRAULIC RAMS. The best modern hydraulic rams or self-acting pumps are economical, reliable and remarkably efficient. To operate them, they require a stream or overflow of water, in which a few feet of working fall can be obtained.

There are two types, one which raises a portion of the same water which drives it, and one which, driven by water from one source, raises water from a separate source.

The ideal site is on a stream where the necessary fall can be obtained by building a small weir. Wherever possible, the site for the weir should be chosen in a straight length of stream to avoid erosion, which may eventually allow the stream to get round the weir.

Concrete is the best material from which to construct the weir, and in small streams it can be of very simple form as shown below :



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The sluice pipe should always be put immediately under the feed pipe to the ram. This ensures a complete scouring of the sediment deposited above the weir, from around the pipe when the sluice door is raised, and should always be done before the mud reaches the level of the feed pipe. The spill way is made rough with large stones to break up the water, otherwise a large hole is scoured out at the tail of the weir.

The amount of fall required is in ratio to the quantity of drive water, the height required to be lifted and the number of gallons required per day. Rams will work with as little as $1\frac{1}{2}$ gal. per minute, and on streams with as little as 2 ft. 6 in. head.

The ram house may be built in brick with a roof, or may take the form of a circular dry brick well with concrete bottom and top with an iron manhole for access.

Care must be taken to see that the waste water drain has a good outlet and that the flood level of the stream will not be higher than the snifter valve on the ram (usually 14 in. above invert of drain). This valve acts as a breathing medium, and if covered or choked suffocates the ram and puts it out of action.

When the source of supply is a spring, the volume of the water is considerably less and a greater fall is, therefore, required for the drive. Several springs may sometimes be collected to the drive tank, and I have rams working on as little as $1\frac{1}{2}$ gal. per minute from this type of supply. In one instance, by collecting three springs, sufficient power has been obtained to drive a ram raising 4,000 gal. per day to a height of 550 ft. over a distance of a mile.

Spring-fed ponds may sometimes be used, if the quantity of overflow is sufficient and the necessary fall can be obtained. Spring-fed land drains can be used in the same way, but care must be taken not to include any water containing what is locally termed "Carr," a yellow sticky substance which is an oxide of iron, and which will cause continual trouble by gumming up the ram.

A good hydraulic ram, properly designed to suit the conditions under which it has to work, is an excellent investment and the next best method to a supply by gravity. They cost very little for maintenance—a few shillings a year, and any farmer, or his man, can (after being shown once) look after them.

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If a stream or spring which is likely to be suitable for driving a ram is available, it is advisable to get in touch with a reputable firm making hydraulic rams, who will send a surveyor to report on the site. He will be able to tell what quantity of water can be pumped per day to a given point. This survey is made for a small fee, usually only to cover expenses.

WINDMILLS. Where a hydraulic ram is impracticable owing to the absence of the necessary flow of driving water or the requisite working fall, a windmill may be considered if the situation is not unduly screened. In this connexion it may be observed that objects more than 100 yards distant can as a general rule be disregarded. The so-called cheap windmills should be avoided, as they usually prove costly in the long run; a modern, high-class, oil-bath type of mill will pump with much less power of wind and little wear.

Windmills may be used in conjunction with wells, ponds, or tanks fed by springs. (I have two very successful supplies from this nature of feed.) Special deep well outfits are available to raise water where the suction is greater than 25 ft.

When inquiring for information and prices from the makers, it is advisable to indicate the source of supply, giving an estimate of the vertical height to which the water has to be raised and the quantity of water to be raised. The diameter, the depth of the water level from the ground, and the depth of water should also be given when describing wells.

PUMPS. If there is a water wheel convenient, pumps can be attached to the axle and the water carried to a convenient tank for the suction. I have made use of this idea by putting a pump on both ends of the axle and by this means raised 8,000 gal. a day to a height of 60 ft.

Low-power, stationary engines are very satisfactory, but there is always the time lost in starting and stopping, the cost of fuel and repairs, but, where other means are not available to lift the water, they meet the purpose. In pumping from a well, it is advisable to gauge the delivery from the engine-driven pump, the inflow of the well and the quantity held in the well. Care must be taken not to over-pump, for if the water is lowered beyond a certain depth in some wells on quicksand there is an inflow of sand. The safety marks can only be found by close observation of the particular well. If it is not possible to maintain the water in the well

FARM WATER SUPPLIES

at the safe level, about 12 in. of clean gravel dumped into the well will sometimes act as a preventative.

There are two types of power-driven pumps, the positive displacement type, where the plunger operates in a cylinder, and the centrifugal type, where pressure or head is generated by very rapidly moving impellers. For pumping relatively small quantities such as are usually required on a farm, a positive displacement type is, in the writer's opinion, the more suitable.

Where current is cheap, an electrically-driven pump has many advantages, and by having a float-controlled switch, the quantity pumped at any one time can be set to suit the inflow into the well or collecting tank and so insure against over-pumping and its consequent troubles. For example, if the storage tank is for 1,000 gal. and the float is fixed to "cut in" at one-quarter the depth from the top, only 250 gal. will be pumped in at once. If the well is 5 ft. in diameter it will hold approximately 120 gal. for each foot of depth, so the water should be lowered only about 2 ft. when pumping. If the well has a slow inflow, it has time to fill before the pump again comes in action.

The depth at which the float switch is set to cut in may be calculated from the depth of water in the well over the bottom of the suction pipe, and the rate of inflow into the well. The latter can be found by marking the well in feet from the bottom and timing the filling to each mark until the water reaches its natural level. By comparing this with the speed of delivery of the pump, the quantity that can be safely pumped can be calculated and the float set accordingly.

Water Divining. If there is no known supply on the farm and no public main within reasonable distance, the services of a good water diviner might be sought. I have sunk eighteen wells at positions found by water diviners, in all natures of soil and rock and varying in depth from 15 ft. to 75 ft., all of which have proved satisfactory. It is a wise precaution to have a trial bore on the site chosen to confirm the findings of the diviner before going to the expense of sinking a well or large bore hole.

Storage. The capacity requirements for storage will be decided by two factors, the daily requirements, and the rate and method of delivery.

FARM WATER SUPPLIES

When the supply is by hydraulic ram, storage is needed for only a day's requirements, and this can usually be attained by putting tanks in the buildings, choosing a position sufficiently high to give pressure to all the points through the house and buildings, remembering that the highest point is usually that supplying the hot-water circulating system in the house.

The size of the individual tanks will be governed by the space available. Tanks of 500 gal. capacity are usually 6 ft. long by 4 ft. wide by 3 ft. 4 in. deep; those of 1,000 gal. 8 ft. long by 5 ft. wide by 4 ft. deep. The walls carrying tanks should be sound and strong as a 1,000 gal. tank filled with water weighs approximately 5 tons, and it is advisable to set these tanks on rolled steel joists in preference to wood.

When a windmill is used, extra storage must be allowed. On the average there is sufficient wind to work the mill five days out of seven, but, unfortunately, one cannot depend on this, as often at certain seasons of the year several days are without any appreciable wind, so storage is advisable for at least three days' supply and for more if possible.

Where engine-driven pumps are used, a day's supply is usually stored; this entails pumping only once per day.

Electric pumps with float-controlled switches do not require so much, and as little as 25 per cent. of the day's consumption should be sufficient to store, although allowing for a whole day would be better.

If there is high ground near the homestead or the pumping plant to give the necessary pressure to raise the water to the highest point required, a storage tank can be built above or below ground in brick or concrete. Failing this, a steel tower and tanks may be erected on the highest ground and taken to the necessary height to give a gravitational feed to all points.

Fittings. Where there is a herd of milking cows, a water-bowl should be fixed before each cow, and a pipe carried to the wall at the back of the cows with a tap for swilling purposes. A drinking-bowl should be fixed in each loose box; a tap in the stable and a bowl for each horse is desirable. Other necessary fittings are a tap and hose union in the cooling-house, taps in the dairy, in the pig-feeding house, and over the wash-boiler and, of course, the connexion for the domestic supply to the house cistern.

FARM WATER SUPPLIES

If the supply is at all restricted, the water used for milk cooling may be piped to a drinking trough in the yard or in a nearby pasture. When a ram is used for pumping, the overflow from the tanks can be used in the same way.

If there is sufficient water and the fields are conveniently near either the homestead or storage, pipes can be taken to field troughs fitted with a ball-valve control and a stop valve to shut off the supply in winter.

Costs. The expense of sinking new wells depends upon so many factors that it is impossible to give any but approximate figures. In free soil and sand, shallow wells up to 20 ft. deep, and lined with brick, may be sunk by one's own staff at round £1 per foot. Wells from 20 ft. to 50 ft. deep and brick lined will cost anything up to £200.

The following costs are from supplies actually installed, covering cost of plant, rising main and storage, but not including service pipes or fittings. All work other than erection of machinery was carried out by the estate staff:

Power pump from pond, lifting 400 gal per hour	£53
Power pumps from new wells, including cost of well. (Average of 2 installations)	£142
Windmill from new wells, including cost of well	£188
Windmill from spring	£129
A type Hydraulic ram on stream. (Average of 7 installations)	£126
A type Hydraulic ram on spring-fed drain. (Average of 12 installations)	£145
B type Hydraulic ram, stream driven, lifting spring water. (Average of 4 installations)	£170
B type Hydraulic ram, pond driven, lifting spring water	£223
Gravitation from springs or ponds. (Average of 3 installations)	£40

The average cost of service pipes and water-bowls fitted to tubular stalls in cow-house, taken from figures relating to the installation of 700 bowls, is 30s. 2d. per bowl, using one of the best single bowls.

PERENNIAL RYEGRASS: SEED PRODUCTION OF BRED STRAINS

GWILYM EVANS,

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Even after a period of approximately three hundred years perennial ryegrass still holds first place in this country as the most-sown grass of all the many sorts of grasses that have been tried. It is one of a small group of herbage plants including wild white clover, cocksfoot, timothy, rough-stalked meadow grass, that appear in time without sowing if the land is sufficiently heavily stocked and the level of fertility increased; hence the group has earned the designation "followers of man." The perennial ryegrass growing in association with wild white clover and contributing heavily to the highest quality permanent pastures of this country is of a very different sort from the stemmy commercial types that farmers have sown almost exclusively for generations. Time was when the saving of perennial ryegrass seed was practised by at least some farmers in nearly all the counties of England and Wales, and a farmer who grows his own seed has always earned the respect or envy of his neighbours. Unfortunately, the local strains of ryegrass were lost when interest in growing ryegrass for seed waned, and the seed production of this grass became concentrated in Ayrshire and Northern Ireland. These two districts together have produced for many years the ryegrass seed supplies of the world. When ryegrass seed production thus became a localized and specialized business growing one generation after another of the grass for seed, the result was the production of the stemmy, comparatively short-lived type which we have known too well.

The picture has, however, changed once more, due to the systematic breeding of strains more suitable for the varying conditions of soil and climate, and the needs of the present-day farmer. Three types of perennial ryegrass have been recently bred at the Welsh Plant Breeding Station: a pasture strain (Aberystwyth S.23), a pasture-hay strain (Aberystwyth S.101), and an early hay strain (Aberystwyth S.24), each of which has been bred for leafiness among other desirable qualities. It is the leaf that builds bone and muscle, and fills the milk pail. The hay strain (S.24) provides grass earlier

PERENNIAL RYEGRASS: SEED PRODUCTION

in spring than the ordinary Irish ryegrass, and although the other two strains (S.23 and S.101) begin growth somewhat later, they are more winter-green, they tiller better and persist longer under heavy grazing than the hay types, in fact, they are truly permanent types under good management.

These new strains have aroused interest in seed production of pedigree grasses throughout the south-east and south of England, as well as most Welsh counties, Northern Ireland and Ayrshire. A considerable number of enterprising farmers have found the seed production of bred strains of perennial ryegrass to be a remunerative side line. Larger areas of the improved ryegrass strains have been laid down every year for seed, and yet the supplies have failed to keep pace with the demand. The effect on seed prices has been such as to attract an increasing number of growers in an increasing number of counties to take up grass-seed production for the first time, and to such an extent that several seed growers' associations, such as the Hereford Seed Growers' Association, the Essex Seed Growers' Association, the South-Western Seed Growers' Association, and the Hay-Talgarth Seed Growers' Association, have been established for the purpose of growing and marketing authenticated stocks of bred strains, or have included such growing and marketing in their activities.

It has not been altogether a disadvantage for these new seed growers to have had no previous experience in seed growing of grasses, for some of the older methods do not apply to some of the new strains. The new seed-growing areas have the distinct advantage of cleaner land, better machinery and rather more enterprise than the older areas.

It is proposed to indicate some of the essential features of the technique adopted by seed growers of bred strains of perennial ryegrass.

Suitable Areas for Growing Seed. For the purpose of seed multiplication, perennial ryegrass is adapted to a fairly wide range of soil types; excellent seed crops can be obtained from soils varying from light sandy loams to heavy clays. It is, however, essential for perennial ryegrass, and especially the pasture strains, to have the soil in "good heart" and ryegrass demands an abundant supply of lime in the soil. The advantage, of course, that deep medium loams have over other soil types is their greater reliability for producing satisfactory seed crops in a variety of seasons.



FIG. 1. Perennial ryegrass, pasture hay strain, Aberystwyth S 101. Grown broadcast for seed. Harvested by mower with reaping attachment. 250 yards from sea. Morfa Mawr, Flanog, Cardiganshire.

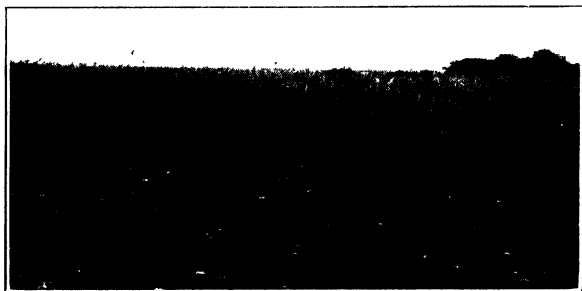


FIG. 2. Perennial ryegrass, pasture strain, Aberystwyth S 23. Grown broadcast for seed. Ryegrass wild white clover hay aftermath in foreground. Ffestiniog, Talgarth, Brecon, at over 1,000 ft.



FIG. 3. Stock seed, Aberystwyth S 23. Sown in 2 ft. drills under oats. Harvested with 8 ft. cut power binder. Pantalls, Sutton St. Nicholas, Hereford.

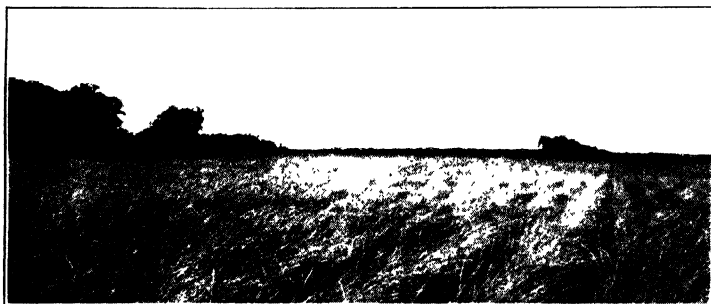


FIG. 4. Stock seed, Aberystwyth S 101. Sown in 2 ft. drills without a cover crop. Bishopstone, Hereford.



FIG. 5. Aberystwyth S 101. Crop seen in Fig. 4 harvested by binder. Sheaves stooked in fours.

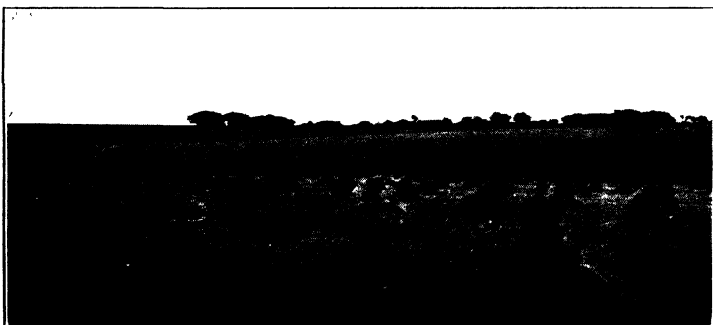


FIG. 6. Seed crop (5 cwt. per acre) of Aberystwyth S 23. Harvested by binder in wet season, 1936. Lower Lyde, Hereford.

PERENNIAL RYEGRASS: SEED PRODUCTION

Elevation is not as important as quality of soil, and climate; satisfactory seed crops of Aberystwyth S.23 ryegrass and very heavy wheat crops can be grown in Breconshire on fertile land at over 1,000 ft. elevation. Grass-seed crops being wind pollinated and conditioned on the field in sheaves, can be grown more successfully in districts where, on account of excessive rainfall, only indifferent red or white clover seed crops can be obtained. Areas not subjected to more than forty inches average annual rainfall would be expected to be able to yield heavy seed crops of ryegrass, other conditions being favourable.

Selection of Ground. In order to safeguard a particular seed crop of pedigree ryegrass from cross-pollination through the agency of wind, it must be well separated from all other types of ryegrass, Italian as well as perennial. A distance of over 400 yd. between the bred strain grown for seed and other ryegrasses grown for hay or seed in the same year is highly desirable; if the distance separating them is less than 200 yd., there is grave danger of pollen contamination of the seed crop. There is little purpose in cutting the offending ryegrass crop for hay after the wind has done its worst in carrying the pollen to the pedigree crop; on the other hand, an adjacent area of ordinary ryegrass may be rendered harmless by hard grazing and the free use of the mowing machine in May and early June to remove any remaining heads.

Another possible source of contamination is the inheritance of buried grass seeds, more especially in upturned sods of old pastures. This danger can be reduced to a minimum by adopting such measures as growing a few cleaning crops, raising the fertility of the land, not allowing the hay crops or young ley aftermaths to run to seed, or allowing sheep feeding on roots to receive hay containing grass seeds liable to germinate.

A systematic grower of high-quality crops of grass seeds arranges his seeding programme each year so that only one strain of each type of grass intended for seed is used. If, for example, he plans to grow Aberystwyth S.23 perennial ryegrass regularly for seed, the seed of no other type of ryegrass will be sown on his farm, and by ploughing up the old swards as well as the young leys as the economy of the farm permits, the chances of pure seed crops increase year by year.

Drills versus Broadcast. Broadcast stands of the new strains sown under cover crops are found to be the most

PERENNIAL RYEGRASS: SEED PRODUCTION

economical method for seed production. Stands sown in narrow drills 4-6 in. wide are virtually broadcast swards and this method is sound practice on soils that are apt to become very dry. Drills, about 24 in. apart, sufficiently wide to allow of horse-hoeing, are employed for growing the more expensive pasture strains when the soil is known to be rather foul with buried seeds of weeds and miscellaneous grasses, and where it is sought to sow the maximum acreage with a limited supply of seed: a fourth of the quantity of seed required for broadcasting is sufficient for wide drills.

Pasture strains are capable of producing their maximum seed yields in the first harvest years from drills, but the seed yields from drills are often lower than from broadcast stands in the second and subsequent harvest years. Ryegrass apparently cannot tolerate horse-hoeing to the same extent as can other grasses.

Nurse Crops. The satisfactory establishment and maximum seed yields of leafy strains of grasses are more certain when the seed is sown without a cover crop. Pasture strains are more sensitive to the suppressing effect of a cover crop than hay strains, and should be sown at the same time as the cover crop from the middle of March onwards. These are very unlikely to interfere with the harvesting of the corn crop. Establishment of ryegrass can be satisfactorily achieved in winter wheat if by courageous harrowing a good tilth can be prepared in March. In addition to the selection of stiff-strawed varieties as cover crops the chances of grass establishment are improved by the sowing of the cover crop at not more than two-thirds the normal rate.

If it is required to sow the grass in wide drills in corn, spring corn should always be used in preference to autumn-sown varieties, as the drills are much more easily cultivated after the corn has been harvested.

Seeding. By increasing the seed rates the adverse effect of unfavourable conditions can to a considerable extent be overcome, but conditions for establishment may be so poor that heavy seeding is unable to effect a satisfactory establishment. Pasture strains of ryegrass require better conditions for establishment than hay types even though they can afterwards persist under less fertile conditions than hay strains. Under favourable conditions even the pasture strains establish well from as little as 16 lb. per acre of seed; sown without

PERENNIAL RYEGRASS: SEED PRODUCTION

a cover crop this seeding has often proved ample. The more usual rate of seeding adopted in the border counties of Wales and England is 20 lb. per acre, added to which are $\frac{1}{2}$ lb. of wild white clover and 5 to 6 lb. of Scotch timothy. The clover is included to form a flexible sward and the timothy to facilitate the harvesting of the ryegrass; its stiffer and longer straw supports the ryegrass seed crop and enables it to be taken up more squarely by the binder canvasses. For sowing in 2 ft. drills, 5 lb. per acre of ryegrass are normally quite sufficient.

Manuring and Management. Phosphates and potash, although not to be lost sight of in manuring grasses for seed, are not nearly as effective in stimulating seed production of ryegrasses as nitrogenous fertilizers such as nitro-chalk and sulphate of ammonia. After a root crop, the land is presumed to be sufficiently well supplied with phosphates and potash for the first harvest seed crop of ryegrass, but a dressing of from 1 to 2 cwt. of sulphate of ammonia per acre has been found to be urgently necessary on pasture strains immediately the corn has been removed. Unless the land is very fertile and the district has comparatively high rainfall this should be followed by a further dressing of sulphate of ammonia in March; the quantities to be applied must have reference to local conditions, but in general the applications are required to be heavier for second year and subsequent harvests than for first harvest year crops. Nitro-chalk can be applied quite well to ryegrass in drills, but sulphate of ammonia is preferable for broadcast areas on account of its greater capacity for controlling the proportion of white clover in the grass.

Grazing is permissible in autumn, but heavy grazing until late in spring coupled with the lack of a nitrogenous fertilizer has been found to lead to a clovery sward and a light seed crop of pasture strains. Hay strains of ryegrass can tolerate spring grazing without injury to the seed crop, but spring grazing should be followed by an application of sulphate of ammonia. These hay strains do not require as much nitrogen as the pasture strains for the first harvest seed crop.

When proper care is taken to keep the crops clean in the field, by eradicating weeds such as docks and thistles, and removing volunteer grasses when they reach the heading stage, the grower can command a higher price for his seed, and the seed could quite well be sown as it comes from the threshing machine without further cleaning.

PERENNIAL RYEGRASS: SEED PRODUCTION

Harvesting. The seeds of the hay strains (e.g., S.24) are ripe for harvest in early July, and of the pasture strains (S.23 and S.101) nearly three weeks later in average years. None of them ripens as uniformly as cereals, and the pasture strains are in this respect less uniform than the hay strains. It is always necessary to allow the spikelets to turn brown and a fair amount of seed to loosen, which can be tested by drawing a few heads through the hand, before the crops are ready for the binder. The stems of the pasture strains may be quite green when the seed is beginning to shed.

A binder with adequate knife speed and adjusted to turn out the narrowest sheaves possible can deal very effectively even with a leafy crop containing a considerable quantity of wild white clover. Ryegrass stems pack closer and retain moisture more tenaciously than do most sown grasses, hence the need for very narrow sheaves to be stooked in fours. Timothy being the driest of all our sown grasses, and commercial timothy being less leafy than bred strains, its inclusion in the ryegrass-white clover seeding does not interfere with the drying of the ryegrass crops in the stook. As ryegrass seed crops absorb moisture more readily than most other grass-seed crops, and dry more slowly, it is essential, if heating is to be avoided, to have the crops condition thoroughly on the field before allowing them to remain in the stack for a considerable time before threshing.

Threshing. Growers who have threshing equipment available find it more convenient to thresh the seed crops from the field; the seed crops are better and the hay—it is quite useful hay—that comes from the thresher, is of better quality. Modern threshers are equipped with screens for grass seeds, and only a few adjustments are necessary for the machine to deal with ryegrass.

In the harvester-thresher combine idea we have a promising method which may in the future supplant the ordinary binder for dealing with standing seed crops of several grass species. One model with a 5 ft. cut, and a corresponding 5 ft. drum, has recently harvested successfully very heavy seed crops of Aberystwyth S.101 and S.23 ryegrasses. The surprising feature of one of these tests was the effective manner in which the machine was able to cope with a particularly dense stand of leafy ryegrass and wild white clover.

Seed Drying. Recent investigations at the Welsh Plant Breeding Station have established the fact that the germinative

PERENNIAL RYEGRASS: SEED PRODUCTION

capacity of ryegrass seed is liable to deteriorate rapidly if it is bagged with a moisture content above 14 per cent.

It is now recognized that the only satisfactory method of drying grass seeds, in order to retain their germinating power over a long period, is to have them dried by artificial heat. Tests at Aberystwyth have shown that it is quite safe to dry grass seeds at temperatures ranging from 95°F. to 105°F. No grass seed drying machine is yet on the market capable of dealing conveniently and satisfactorily with the seeds of various species of grasses. The Welsh Plant Breeding Station has recently constructed a drier to overcome the difficulties encountered in grass driers. In the absence of a special seed drier freshly-threshed seed can be conditioned for bagging, by turning daily on airy floors, or by placing canvas sheets over the perforated grids of grass driers unless grid floors with perforations to suit each type of grass seed are available.

Touch by hand is not sufficiently sensitive to estimate 1 per cent. differences in moisture content, hence the need for a simple and reliable apparatus which can be used on the field or in the granary. This is found in The Davies Moisture Meter, an instrument which can be invaluable to the seed grower and seedsman.

Yields. The plant breeder having set out to breed a characteristically pasture strain of ryegrass, it is not to be expected that such strains as Aberystwyth S.23 and S.101 can produce more than two-thirds the seed yields of hay strains, but this is not a serious disability to the seed grower as long as the price level of the seeds remains, as at present, at several times the value of the seeds of ordinary ryegrass strains.

Yields as high as 7 cwt. per acre have been obtained from a pasture strain (S.23); yields of from 4 to 5 cwt. are not uncommon, but a more frequent yield that can be expected on many types of land is of the order of 3 cwt. per acre. Improved hay strains (Aberystwyth S.24) are more densely tillering than the ordinary Irish or Ayrshire perennial ryegrass. They are quite as prolific in seed production as the older types, and very satisfactory seed crops can be obtained in the second harvest year as well as in the first.

The threshed straw from broadcast stands of the new ryegrass strains contains a fair proportion of ryegrass leafage, together with wild white clover and timothy. There are records of threshed crops of S.23 ryegrass weighing 2 tons and

PERENNIAL RYEGRASS: SEED PRODUCTION

2½ tons per acre respectively having been baled and sold as hay. The straw of the hay strains contains less clover and is of lower value.

Flexibility of Leafy Ryegrass Swards. Of all the improved strains of grasses the leafy pasture strains of perennial ryegrass afford the widest scope for a variety of purposes, having been bred for density of tillering, quality and permanency. The possibility of intensive seed production can be exemplified by reference to the experience of a Herefordshire grower who has grown in successive years on a six-acre field of medium loam soil a crop of seed oats (1934), malting barley (1935), seed crop of pasture ryegrass Aberystwyth S.23 (1936), another seed crop of pasture ryegrass S.23 (1937), wild white clover seed crop (1938), hay crop (1939). Approximately 5 cwt. per acre of seed ex-thresher were obtained in the wet season of 1936, and a similar quantity in 1937. The sward is such at present (1939) that with appropriate treatment it could be utilized in future years for any of these purposes and the clover content of the sward guarantees an abundance of fertility capable of growing heavy corn crops.

A leafy hay strain of perennial ryegrass such as Aberystwyth S.24 with white clover sown in addition can produce grass-seed crops in two successive years, and a white clover seed crop in the third year after hard grazing in autumn and spring. The S.24 ryegrass strain can provide earlier grazing before putting it up for seed than any other known perennial ryegrass, and under conditions of high fertility it may persist for several years. A grower realises the flexibility of even hay strains of ryegrass, for he has the option in any year of using the sward for ryegrass seed, clover seed, hay, grass cuts or grazing as the exigencies of the moment demand.

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LEY FARMING FOR LAND IMPROVEMENT

T. NELLIST WILKS,

Whartons Park, Bewdley

Up to 1920, the farms comprising Whartons Park, Bewdley, in the County of Worcester were typical of the upland stock-raising lands of the West Midlands. Since the depression of the '80's, they had been seeded or allowed to seed themselves on no particular plan, and both cultivations and fertility had suffered to a serious extent. About one-fifth was still under cultivation of a sort and of the remainder much was overgrown with thorn and gorse. The turf was made up of bent, fescue, some molinia and a little wild red and suckling clover in places, generously interspersed with a variety of grass-land weeds. The stock-carrying capacity of such land was very low and the whole of the farming activities were in a state of stalemate. The soil proved sour and with no bacterial activity. Of the land under cultivation practically the whole was suffering from a very hard plough pan about four inches below the surface. Apparently this had been accentuated by the use of a heavy-wheeled tractor during the War and was also sour and contained little or no humus. In addition it was very foul, due probably to the shortage of labour during the War period. Only a very small proportion was in rotation ley and moderately good. Again, probably due to war exigencies no attempts had been made at improvement and there was a derelict appearance everywhere. Such was the state of affairs which the writer found when he took over.

During the first year or two the Agricultural Organizer for the county had been frequently consulted with a view to discovering the best methods of improvement, and several manurial experiments were laid down to ascertain the reactions of the soil. The main outcome of these experiments was that basic slag was the best source of phosphoric acid to use and that there was a need for potash in some form in conjunction with nitrogen when used. Heavy dressings of slag produced an improvement, marked in the first instance, but gradually diminishing with successive applications. The

LEY FARMING FOR LAND IMPROVEMENT

effect appeared to be most marked on the clovers, wild white making its appearance and becoming very vigorous. The wild red clover and suckling clover also benefited, in fact, the latter became dominant in some of the pastures to the detriment of the grasses. This produced no real improvement as, in very dry weather, the suckling clover disappeared, leaving the bare land and giving the deeper-rooted weeds such as rib-grass and plaitain every chance of taking command when rain came again.

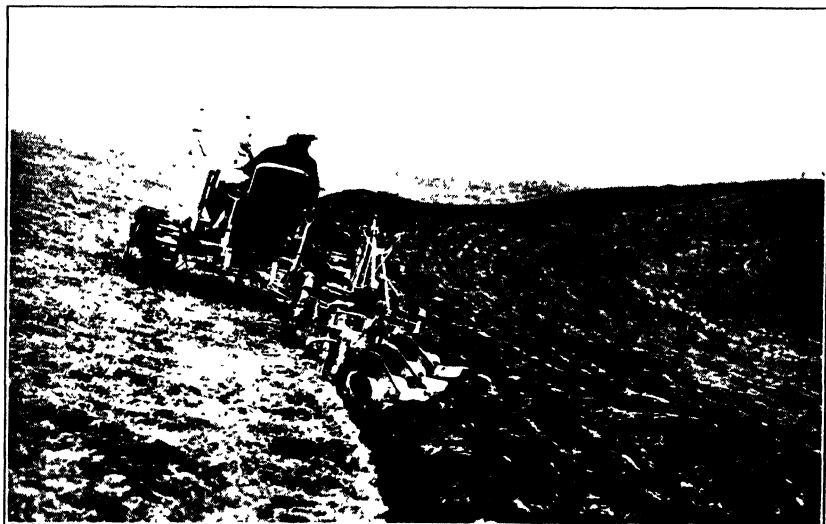
On the arable land improvement was more sure, and by the generous expenditure of horse and manual labour the output was gradually improved, especially after the temporary leys which were used for the production of hay. The growing of sugar-beet as an additional crop in the root break made a marked improvement in output and soil condition.

By 1933, however, it appeared as if the limit of improvement by the ordinary orthodox methods had been reached, and there remained still much to be desired from the land, especially that under grass. Livestock was not showing the improvement normally expected. This was particularly disappointing as a thorough-going grading-up scheme had been followed from the first. Evidently the land or its management or both were at fault and were discounting the benefits of using improved sires in the herd. On the whole, financial results left much to be desired and a review of the position showed that there was need to tackle the problem from some fresh angle.

Change-over to Ley Farming. After careful consideration and consultation with the Agricultural Organizer again (the value of whose help cannot be overstated) it was decided to visit the Land Improvement work being started by Professor (now Sir R. George) Stapledon and his colleagues on the Cahn Hill Improvement Scheme. Accounts in the Ministry's JOURNAL and elsewhere of Sir George's work had aroused the writer's interest, and it was thought that such work might be of considerable assistance with the problems at Whartons Park. How true this proved to be, was not realized until after this and subsequent visits. Inspiration and ideas by the dozen were there to be had for the asking and the foundation of the idea to apply ley farming to the land at Whartons Park was laid. Odd fields of old turf had been ploughed out a year or two previous to the visit to



FIG. 1. Clearing derelict land



Ploughing out the old sod with 3-furrow, bar point plough and wide model tracklaying tractor



FIG. 3 Heavy discing to break up the root mat

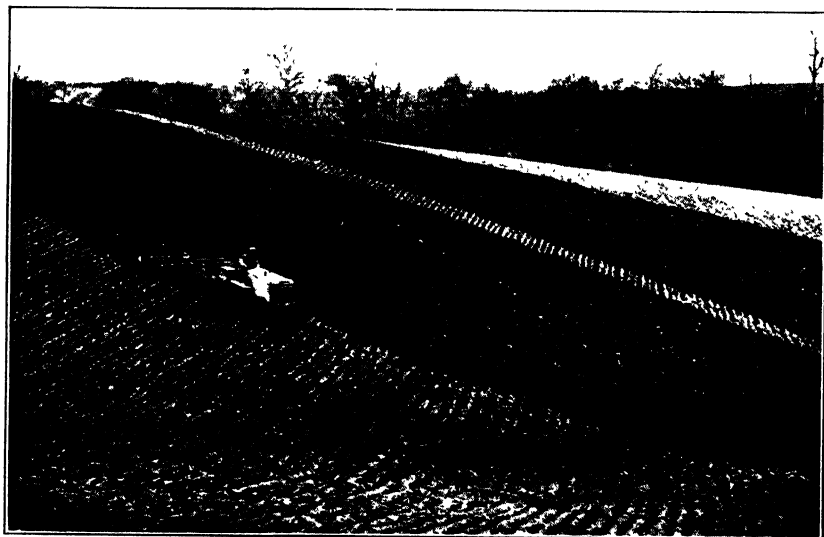


FIG. 4 Working a seedbed with discs

(The photographs in this inset are by courtesy of the "Farmer and Stockbreeder")

LEY FARMING FOR LAND IMPROVEMENT

Aberystwyth but with indifferent results, due, no doubt, to the lack of knowledge of a suitable technique. A full discussion with Sir George Stapledon and his colleagues, covering the whole problem to be faced, made it possible to formulate the framework of a plan of ley farming applicable to the land in Worcestershire. The main question was the establishment of leys to replace the old turf ploughed out in such a way as not to interfere with the livestock policy of the farms and at the same time maintain the output of crops cashed directly, such as sugar-beet and wheat. It needed a nice balance to be struck to accomplish this, and but for the advice and demonstration from Aberystwyth it is doubtful if such a change-over would ever have been considered possible, let alone advisable. Much time and thought were expended in filling up the details of the plan and translating ideas into practical working programmes. One of the first questions to be decided upon was that of facilities for cultivation. Hitherto, horses had been relied on entirely and experience had impressed on the writer very forcibly their limitations. Perhaps there had been an undercurrent of prejudice against the use of tractors due to the adverse effects of a heavy-wheel machine on this type of land. Here, again, the Cahn Hill work helped in coming to a satisfactory decision, for the demonstration of the capabilities of a track-laying machine shown there, led to a demonstration at Whartons Park in 1936 and the eventual decision to use one of this type of tractor for motive power instead of more horses. Many factors led to this decision, but the two outstanding ones were these: (1) the ability of the machine to tackle any job (without exception) which the cultivation policy of the farms required and (2) the very much more extended and efficient use of which could be made of the limited amount of skilled labour available. This amounted to three times in favour of the tractor. Furthermore, the fact that the machine was of a special type designed for use on hilly land, made it possible to cultivate land hitherto regarded as impossible with either horses or wheel tractor. The adoption of this means of motive power opened up all sorts of possibilities on the not very easy working land, and the planning of a suitable technique became much simpler. It should be mentioned here that co-operation of the workers was wholehearted and enthusiastic. Efficient with horse implements they soon became proficient with the tractor counterparts and threw

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themselves wholeheartedly into the game. This was a vital factor, of course, and without it no scheme, however well planned, could hope to succeed.

With a winter's successful mechanical cultivation experience in hand (incidentally, one of the most difficult from a weather point of view ever experienced), it was decided in the early part of 1937 to make a start towards getting all the land into the ley system. The main plan was to break up the worst of the old turf first and seed down the more stale parts of the existing arable with various types of seeds mixtures.

A Flexible System. It was a case of "trial and error" at first, and experience had to be gained in several directions before a rigid plan could be adopted. Curiously enough, one of the first lessons learnt was that the ley system was extremely flexible and that it was never necessary to have too hard and fast a rule of working. From the little experience gained in previous years, wireworms were bound to be encountered in the old sods and the sowing of spring cereals (or winter cereals for that matter) without some means of controlling that pest was only waste of time. Short-term leys consisting of commercial Italian and perennial ryegrass with broad red clover were therefore used as a first crop on the turf ploughed out in the late winter. These proved very successful. Their success was due to adequate cultivations to secure a firm and friable top seed bed and to the attention paid to the question of the restoration of fertility at the time of planting the seeds. Although there was fertility locked up in the old sod it would not become available quickly enough to start the young seedlings. These temporary leys provided grazing within eight weeks of sowing and provided an enormous amount of feed in the seeding and harvest year. They also provided an excellent preparation for the start of any rotation subsequently decided upon. The leys sown on the stale arable land were of the long-term variety advised from Aberystwyth and consisted of simple mixtures of strains of one or two principal grasses with wild white clover and some late-flowering red clover, all pedigree, with a small addition of commercial Italian and perennial ryegrass to give the first bite and allow the slower starting pedigree seeds to get a hold. The combination of short- and long-term leys carried an increasing head of stock of all kinds, and more than made up for the land ploughed out. It was found that one acre of new ley would

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compensate for three to four acres of the old stuff. The short leys cut an excellent crop of hay in harvest year if required.

Another method of dealing with the old turf in the first instance was to graze hard, or mow, and in mid-July cut up the sod with heavy discs to a depth of three to four inches. This made a loose mulch which could be moved about once a week for several weeks during August and early September, and allowed for the exposure of the wireworm to the birds. It was surprising how the latter appeared to realize that the soil was being moved for their benefit! The loose mulch was then ploughed down towards the end of September in preparation for autumn wheat. An excellent crop untouched by wireworm followed. Although the main idea was to put the newly-ploughed land through a rotation of crops, the use of a short-term ley in the first instance as a preparation for a long ley proved just as useful for a very hilly inaccessible field which appeared unsuitable for arable crops. This field provided ample demonstration of the capabilities of the track-laying tractor, in that some of the slopes had a gradient of one-in-two and even steeper, and, in addition, were covered with heavy thorn and gorse. It was successfully and profitably cleared, ploughed, worked to a seedbed, limed and fertilized exclusively with the track layer, and sown with a temporary mixture. Although this piece of land had carried no stock for many years the resulting ley carried stock within eight weeks of seeding and carried its full complement of mixed stock for eighteen months, when it was ploughed again, worked and fertilized, and has now been sown out with a long-term ley which at the moment of writing, is nearly ready to carry stock five weeks after sowing. It has been estimated by experts that this land has been increased in value, to the tune of twice the cost of the renovation, in addition to the keep it has yielded.

Previous to the purchase of heavy discs, light ploughing was tried as a means of both breaking up the old sod and exposing the wireworm and also destroying the heavy weed infestation. This method was not a success, however, owing to the dense nature of the root mat and the impossibility of parting it once it had been loosened from the underlying soil. It defied all ordinary means of breaking it and the field presented a sorry sight. Eventually it was reploughed for wheat, and a good crop resulted, but the weeds survived and had to be dealt with in the following season. Very little wire-

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worm showed, however. It has been noticed that the heavy discing assisted materially in the rotting down of the old sod and the additional aeration appeared to accelerate bacterial action. The heavy disc proved the most useful implement for preparing a seedbed as it did not disturb the furrows after ploughing and appeared to aid in consolidation as well. The manuring of the upturned sod was a comparatively simple matter. Being inherently sour, some form of lime was needed, and ground carbonate was used on account of its easy handling in the distributor. Further, early experiments in the county had proved its suitability. Phosphates were supplied in the form of basic slag, usually of high grade and always of high citric solubility. Where potash was used the grade was 30 per cent. salts, and, as a starter for the young seeds, nitro-chalk proved most useful.

Enough has been said on the matter of technique to show that it is of vital importance in any scheme of improvement. Considerable expenditure of time and money are involved, and their misuse would prove disastrous from the start. At Whartons Park the judicious and efficient use of mechanization came with experience and too costly mistakes were avoided. As the scope of the cultivations increased it became apparent that tractors and horses did not team up well together and after a year's working it was decided to purchase another track layer and dispense with all but an odd horse or two for small jobs. This gave complete control of cultivations and in such a way that the best use could be made of limited weather opportunities and also gave an all-round increase in speed of working so essential on heavy soils. The writer would almost be bold enough to say, that without mechanization, under present labour conditions at any rate, land improvement on the type of soil being described would not be a financial and, in some instances, not a physical possibility. Much remains to be done and to be desired in the sphere of mechanization of land operations, but that is another story.

Increased Stock-carrying Capacity. The year 1938, although a very abnormal year from a weather point of view, brought results which confirmed the success experienced in the previous year. It had been fully realized that if improvement was to mean anything at all it would mean increased stock-carrying capacity, and to meet that requirement an

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additional number of steers were reared in 1937. (The herd of Shorthorns is Attested and self-contained.) In addition, a larger number of heifers were retained owing to a marked improvement in their conformation. Altogether, the head of livestock carried amounted to an increase of 25 per cent. over the previous year. It was not without misgiving that the drought which the Midlands experienced during the first half of 1938 was faced, but the position was never serious in spite of the increased head of stock. The young leys met the drought conditions admirably, and the situation when reviewed, even under drought conditions, was so satisfactory that a further increase in rearing was embarked upon to the extent of another 25 per cent. in readiness for 1939. This may appear to have been unduly optimistic, but such was the confidence which the leys had inspired, that short of some major catastrophe, the writer felt certain he would get his keep. The wintering of such a largely increased head of young stock called for careful management and rationing of fodder, but here again, by extending the grazing period further into the late autumn and commencing earlier in the spring the leys helped matters considerably. Grazing was available well into December and for the older animals into January, and was generally available for all classes of stock by the first week in April. Between these periods January-born lambs were being fattened on the Italian ryegrass of the short-term leys with a minimum of concentrated food.

Of the cereals, those sown after the broken-up turf showed a decided advantage over those on the stale soils. It was very evident that the humus from the old sod had conserved the moisture and enabled the crop to feed even in the driest periods. The yield at harvest was also considerably heavier. Lodging of the grain after old turf was teared at one time but did not happen, probably due to the balanced nature of the fertilizers used coupled with a suitable variety of wheat, i.e., Victor. The quality of the grain also appeared to have improved, good seed samples being produced.

Animal health was another direction in which improvement was hoped for and realized. In previous years a certain amount of trouble had been experienced with sterility amongst the cows and heifers in the herd. Intensive search by the research departments at Cambridge failed to reveal any specific cause, and by a process of elimination the cause narrowed itself down to nutrition. Apparently the new pastures,

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better supplied with minerals, etc., and being natural food-stuffs suited the animals better, and within a year the trouble disappeared. Taken as a whole, the results in general are very encouraging, and although it will be some time before the full financial benefit is felt, the immediate returns are not inconsiderable. They go a long way to providing liquid capital to finance further developments, a very important advantage.

It will probably take another two years to complete the ploughing out of all old turf. The long-term leys will be quite equal to the task of providing keep, however, even though they may slow down a bit as they get older and further from the plough. They are certainly storing up fertility in the form of active humus and other essential plant foods which will become more readily available as soon as the leys are ploughed out. The question of the release of lock-up fertility is one which the writer hopes to study from a practical point of view when the long-term leys are eventually ploughed out. In this connexion it is interesting to note that in an article in the May issue of this JOURNAL, Hanley concludes that the plough is probably the best means of preventing the excessive fixation of phosphates and in effecting the release of reserves.

Long-term Leys: Herb Strip. Another interesting experimental feature has been included in the 1939 long-term leys. This is the sowing of a herb strip across the field of about one-tenth of the area. In the latest Bulletin issued from the Welsh Plant Breeding Station this practice is advised, at least experimentally. The writer has often felt that the complete elimination of herbs (sometimes classed as weeds) may create a danger that the animal is being deprived of possible valuable mineral or medicinal elements not yet thoroughly understood, but essential to health and well being. In a similar way the question of variety in the herbage offered to stock is being taken into account. Practice has proved that the advice given from Aberystwyth is good in that it is preferable to use a mixture of strains of one or at the most two of the main species of grasses with clovers, than to use too many species in a single mixture. By varying the grasses in the leys of different fields it is possible to give the animals the variety they seem to like and need. Grazing management is made much easier by this means, too. Probably this will lead to the use of each type of herbage at its best time, that

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is at the period of maximum growth, when undergrazing and overgrazing, both undesirable, can be avoided. This should tend to spread the amount of feed more evenly over the grazing period. It has been possible to fill in gaps by varying the date of sowing the short-term mixtures, but this is governed by weather conditions to some extent.

The position at Whartons Park at the time of writing can confidently be said fully to justify the changing over to ley farming. It is gratifying to reflect that no interference with the normal output of the farms has taken place. Indeed, output has been assisted and accelerated by the change-over and is increasing steadily. The returns have more than justified the cost. It would be idle to suggest that such increased activity meant no extra expenditure from the former level, but what the writer anticipated when he first contemplated the venture has proved to be correct, i.e., that the increased output would result in a lessened cost and larger turnover, with a more sure and steady output as well. These are vital factors in any productive enterprise. Further, the quality and hence the value of the products has increased. Mistakes in plenty have been made but they have taught valuable lessons rather than led to trouble, and the future is being faced with more confidence than has ever been possible in the past.

In conclusion it may not be out of place to record the value of the financial assistance which the writer has received from the various Government schemes for helping agriculture. Each has been taken full advantage of as it became applicable, and has been of very great assistance in what appeared at first a very formidable task.

SYSTEMS OF DAIRY FARMING*

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The importance of dairy farming and the extent to which it has developed in the last thirty years were emphasized in the introductory article of this series (see the May issue). The value of milk and dairy produce sold off farms in Great Britain is now about £65,000,000, or more than a quarter of the total receipts off the land; thirty years ago the value was less than half this sum and only constituted one-fifth of the total output. Dairy farming is now a leading branch of agriculture in almost every county in Great Britain except in the mountain regions of the north and west, and in the arable areas of the east. In England and Wales alone, the total quantity of milk sold under the Milk Marketing Scheme in 1938-39 was over 1,080 million gal., of which 763 millions were sold for liquid consumption and 317 millions for manufacture, including 23 millions made into cheese on the farm. In Scotland, under the Scottish Milk Marketing Scheme, the total quantity of milk sold off farms from October, 1937, to September, 1938, was 122 million gal. Nearly 45 million gal. were sold for manufacture, including over 6 million gal. of farm cheese milk. To these quantities must be added milk consumed in farm households or by farm employees, and the considerable quantities used for calves and for butter-making in the cattle-rearing districts. As another measure of increased importance, it may be noted that the number of cows and heifers in milk or in calf in Great Britain increased from 2½ millions in 1908 to 3½ millions in 1936. During this period, the average yield of milk has undoubtedly increased so that the actual increase in dairying is considerably greater than these figures would suggest.

Distribution in Relation to Markets. In view of the fact that, of the milk sold off farms, about 70 per cent. is intended for consumption in liquid form, and that milk is a relatively bulky product which deteriorates quickly in storage, it is natural that systems of dairy farming still depend to some extent on accessibility of the farm in relation to consuming centres. It must be added, however, that modern

* This is the third in a series of articles by Professor White on "British Systems of Stock Farming." Earlier articles, on *Cattle Rearing* and *Summer Fattening on Grass Land* appeared in the May and June issues respectively.

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methods of producing, handling and transporting milk have effected great changes, so that the old, clearly-defined zones have become much less distinct.

TOWN DAIRYMEN. At the one extreme, there is the town dairyman, who has a cow-house and at most a paddock which is little more than an exercise ground. Usually, he sells milk retail, and his situation near to his customers used to be a great advantage as, unlike producers at a distance, he was able at all times of the year to deliver milk in sweet condition. It must be remembered that until quite recently in many small towns consumers preferred their milk to be delivered uncooled. The town dairyman buys everything he requires, including cows, hay and straw as well as other foods. He milks the cows so long as they produce a reasonable yield, and then sells them fat, replacing them with other animals newly calved or on the point of calving.

This system still survives to a limited extent, though it has almost died out in large towns except in Liverpool and Edinburgh. In these two cities, there are important brewing, milling and oil-crushing industries, whose by-products are available within easy carting distance. Moreover there is also within easy reach of both a large area of land used for intensive cultivation which provides a good outlet for the large quantities of manure produced. Under other conditions the disposal of the manure often presents difficulty. Most of the cows used in this system are good, dual-purpose Short-horns, because this type is undoubtedly particularly well suited for milking and fattening simultaneously.

Many factors have contributed to the decline in town dairying. One of the most important is the great reduction in the demand for fat cows. Formerly, a good fat cow, five or six years old, would make within 5s. or 6s. per cwt. of the price of a fat bullock; now, the price of fat cows rarely approaches 30s. a cwt., even though the price of bullocks may be 45s., and cows do not qualify for the beef subsidy. At the same time, the great increase in milk production has kept up the price of dairy cows, so that £30 or more may have to be paid for a newly-calved cow which 10 or 12 months later is not likely to be worth more than £13 or £14.

MILK FARMS NEAR TOWNS. At a little distance from a town, but still within the range of a milk float or van, will be found farmers who have a moderate area of grass land and possibly a little arable. They, too, generally retail their

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milk, and usually feed largely on purchased foods. The amount of hay that they can make may, or may not, be sufficient for the needs of the herd during the winter, though in any event their purchases of hay will usually be small compared with those of the town dairyman. In addition to this, they have also the great advantage of being able to keep their cows for more than one lactation period. In most instances no calves are reared, but the cows are bred from, and thus the depreciation on the cow—which in the town dairy is concentrated in the one season—is spread over two or three years.

The two foregoing classes include the majority of producer-retailers. In England and Wales, there are over 60,000, and the total quantity of milk sold by them in 1938-39 was about 136 million gal., or nearly 18 per cent. of the total sales of liquid milk. Though numerous, their scale of operation is on the average rather small. The remaining 82 per cent. is supplied by less than 100,000 wholesale producers.

CHEESE-MAKING FARMS. Still farther from the consuming centres on land suited for the production of large quantities of milk, will be found the class of farmer who, until recently, could not safely sell milk during the summer months, when risk of souring during transit was serious, and when costs of carriage were high in proportion to the price of milk. In summer, therefore, cheese was made on such farms (or, in a few instances, cream or butter was produced) and in winter, when the cost and risk in transport were relatively low, milk was sold and transported in churns by train. Nowadays, most such farms sell milk all the year round. Modern methods of cooling and transportation have overcome the previous difficulties of dealing with summer milk, and, in addition, milk depôts and factories have been established in nearly all dairying districts.

In districts naturally well suited for milk production, but far from large consuming centres and not well served by railways, farmers until a few years ago were unable to sell their milk either in winter or summer. Cheese-making provided the best means of exploiting the natural suitability for milk production. In the typical English cheese-making area, most of the land is in permanent grass. In south-west Scotland, arable cultivation with temporary leys is more common.

On suitable grass, milk can be produced very cheaply in summer, but in winter it involves purchase of concentrated foods and is more difficult to make into cheese, so that the

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common system on cheese-making farms is to have nearly all the cows calving in March or April. Thus they are in full milk during the months when the grass is at its best. They are milked throughout the summer and allowed to dry off in autumn, so that during the winter they can be kept very cheaply—almost entirely on hay.

The feeding of pigs on a large scale is almost invariably an accompaniment of cheese-making, and this is perhaps the most satisfactory means of securing a return from the whey.

Apart from the developments already referred to, which have opened up the liquid milk market to farmers who were formerly unable to take advantage of it, the labour involved in the making of cheese in the farm-house has been largely responsible for the decline in this type of farming. It is heavy work which has to be done seven days in the week, and, owing to the difficulty of obtaining help, the change to milk selling has been made in many instances to relieve the farmer's wife. The institution of the Milk Marketing Scheme, which provided an assured market for all milk produced, greatly accentuated the decline in farm-house cheese-making, hence the special provision now made under the Scheme for the encouragement of this branch of the industry. The number of farm-house cheesemakers in England and Wales had declined to 820 in 1934-35, but has since been restored to about 1,300. Given the requisite skill and proper management, the quality of farm-house cheese is usually well above that of the factory product which has to be made from milks of varied origin and age. In the interests of the industry, therefore, it is to be hoped that the system will survive, and regain something of its old importance.

BUTTER-MAKING AND CATTLE-REARING. In the most remote areas of all, on land of a quality not suited for large-scale milk production, butter-making and cattle-rearing are carried out. In recent years, with the development of motor transport, and particularly since the development of the Milk Marketing Scheme, dairy farming has extended to farms and districts where previously it was impracticable. The financial attractions of milk selling, compared with other systems of farming, have also led to its encroaching on areas which were previously entirely devoted to completely different systems, such as arable farming, or summer fattening.

Distribution in Relation to Soils. Climate, etc. The above classification of dairy farming—mainly milk selling—

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is based chiefly on the accessibility of available markets in the consuming centres. Modern methods of handling and transporting milk have greatly reduced the effect of this factor, though it will, doubtless, always be of considerable importance. In any case it is also necessary to consider the distribution of dairy farming from another point of view, viz., the suitability of soil, climate and other conditions for the economical production of milk.

Here again, the boundaries of the clearly-defined regions, which could formerly be easily distinguished, have become very blurred. The chief reason is the fact that the financial returns from milk selling have been for many years more satisfactory than those from many other branches of farming. The result has been that dairy farming has been taken up in new areas, including many which are naturally better suited for other systems. If these once again become reasonably remunerative, it may be anticipated that there will be some reversion to the old types of farming.

DAIRY PASTURES. The three main items of expense in the maintenance of a dairy herd are food, labour and replacement of cows. Of these, the first is the most important. Of all foods available for milk production, the cheapest and by far the most important is grass of good milk-producing quality. Less attention appears to have been given to the study of dairy pastures than to fattening pastures, and it is quite impossible to say exactly what constitutes good dairy land. At the same time, the character of such land is usually well known locally, and even on an individual farm certain pastures are regarded as first-rate cow pastures, whilst others which possibly appear very similar have the reputation of inducing the cows to fatten rather than to produce large quantities of milk. Some idea of the distribution of the districts in which good dairy pastures occur to the greatest extent will be obtained by mapping out the areas which have long been associated with cheese production. As indicated above, such areas derive no advantage from their situation in relation to large markets; therefore, their mere association with cheese-making indicates the natural suitability of the land for milk production. Of these areas, the two oldest and most important are the Cheshire district, including parts of the adjoining counties of Flintshire, Denbighshire, Shropshire and Staffordshire, all long associated with the manufacture of Cheshire cheese; and the Somerset area, the original home of the

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Cheddar cheese, including parts of adjoining counties, particularly Wiltshire and Dorset. The south-west of Scotland also has for many years been an important centre for the manufacture of the same type of cheese.

Smaller cheese-producing areas are to be found in other parts of the country, for instance in Lancashire, and on a much smaller scale Leicestershire (the home of the Stilton cheese), North Yorkshire (Wensleydale) and South Wales (Caerphilly).

CLIMATE. Any attempt to find conditions common to all these districts will show that, with the exception of Leicester, they all lie to the western side of the country and are characterized by a mild, moist climate with a moderate well-distributed rainfall; this ensures a long grazing season and a steady growth of grass unlikely to be stopped by prolonged drought. On the other hand, the excessive rainfall of some extreme western and north-western districts shortens the growing season owing to the damage done to wet land by the trampling of cattle, and also makes it difficult to secure first-class hay.

SOILS. The soils of these areas vary considerably both in nature and origin, but in the main they are heavy in character, probably containing more clay than many of the silty soils associated with fattening pastures, and not usually so deep as the latter, though no opinion is expressed as to whether this has any connexion with the differences between the characters of the two types of pasture. Abundant supplies of lime and phosphate appear to be essential, and it will be found that the traditional system of management makes up for any natural deficiencies. For instance, in many parts of Cheshire, an old marl pit, now usually a pond, is to be found in almost every field, and the traditional use of bones on the pasture still survives, though marl and bones have in the main given way to other forms of lime and phosphate. On the best dairy pastures, it will generally be found that the botanical composition of the herbage is not dissimilar to that of the best fattening pastures, though usually more varied in character. Perennial Ryegrass and Wild White Clover are much the most important ingredients, but why on one pasture these species should enable cows to produce large quantities of milk, whilst on another they promote fattening rather than milk production is a problem which has still to be solved.

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Labour Problems. The question of labour is largely linked up with the size of the farm, and the traditions of the neighbourhood. The great majority of dairy farms are comparatively small and worked mainly by family labour. The importance of this is easily realized if we consider a grass farm of 120 acres carrying a dairy herd of 60 cows. If full-time labour had to be hired on a sufficient scale to cope with the milking, it would be difficult during the greater part of the year to find productive work for the staff so employed. Where there is a tradition of dairying, everyone on the farm, including the farmer's family, has learned to milk at an early age, and part-time milkers, including children of school age overcome the difficulty. With smaller families and the reluctance of all classes of the community to be tied to any work on seven days every week, difficulties often occur even in the dairying districts. In other areas, particularly in the arable districts, milking has always presented a big problem. In all instances, however, the milking machine has done much to solve the problem.

Replacements. The question of the replacement of dairy cows is another factor which influences the system of management very considerably. As already mentioned, the difference in the value of the animal as a newly-calved cow and as a fat beast is considerable. Moreover, the risk of introducing disease when purchasing cows is serious. There is, therefore, generally a tendency wherever possible to make the herd at least partly self-supporting by rearing home-bred heifers and by keeping cows as long as possible. A great deal, however, depends on the suitability of the farm for milk production. If of first-rate dairy quality, it is naturally desired to exploit that quality by keeping the maximum number of cows in milk, so that few heifers are reared. At the other extreme is the farmer who has poor land of low milk-producing quality and not well situated for the sale of milk. His dairying may be subsidiary to the sale of cows and heifers which can be reared at least as well in some of the upland districts as in the best dairying areas. The Ministry's Attested Herd Scheme has shown that in many of the poorer districts, cattle are much freer from disease than in the intensive dairying areas. Moreover, there appears to be some basis for the general belief that heifers reared on good land and relatively rich grass do not develop into such good milkers as those fed on bulky, less nutritious food during their growing period.

SCIENCE AND THE FARMER

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Farmers often complain about the growing difficulty of following the progress of agricultural science; the trouble is indeed not a new one, but science is becoming more and more highly specialized, and it is becoming ever harder for the farmer to understand what the scientist is trying to tell him.

Sometimes the trouble is a mere matter of words. For instance, when a writer on animal feeding speaks of *avitaminosis D*, he is using a term that any expert in the subject will understand, but which may convey no meaning whatever to a reader of normal intelligence and average education. Moreover the word is probably not in the dictionary, so that the reader must either give up the attempt to understand or else call in an interpreter. If the interpreter explains that *avitaminosis D* means "the group of symptoms produced through a deficiency of vitamin D in the animal's food" which again means, roughly speaking, rickets, then the point is reasonably clear.

Sometimes, again, the research worker is inclined to assume that we have all recently gone through the science side of a modern secondary school. A phrase like *the hydrogen-ion concentration of the soil solution* may probably have a clear and precise meaning to a schoolboy who has done a two-year course in chemistry, but must be meaningless to those of us who have had no time to follow the recent development of chemical theory. Moreover, if we translate into plain English we must be content with something like "the degree of sourness of the soil" which does not give the exact meaning.

Finally there are other instances where a scientific theory is quite beyond the comprehension of any but a specialist in the particular branch of science, and where the rest of us, if we try to grasp the argument, will achieve nothing but a headache. Here the scientist might reasonably be expected to warn us off, and to content himself with pointing out the practical lesson, if any. We on our part must content ourselves with the thought that the proof of the pudding will be in the eating.

SCIENCE AND THE FARMER

The writer has been asked to explain, in this series of notes so much as he understands (or hopes that he understands) about some of the more important of recent developments in the science of agriculture.

I. Soil Reaction and Lime. Thirty years ago, when some of us were students, soil science was one of the more easily understandable branches of agricultural learning.

In those days the soil contained four simple and distinct kinds of matter. In an ordinary soil the bulk consisted of solid, stony particles differing one from another chiefly in size. They could readily be sorted out into their various size groups and these were called by ordinary names—stones, gravel, coarse sand, fine sand, silt and clay. The only other point was that, if the soil was to be fertile, some of the particles should be limestone or chalk rather than any other kind of stone.

The second component was the soil moisture which was, of course, not pure water but which contained, in ordinary solution, small amounts of nitrates, potash compounds and other salts. It also contained some carbonic acid and was thus able to dissolve, from the stony particles, substances that were insoluble in pure water. The plant obtained its food by drawing in this solution through its root hairs.

In a properly-drained soil the soil moisture was present only as a film on the surface of the soil particles, and for the rest the spaces between were filled with air. This air contained more carbon dioxide than the ordinary atmosphere, which fact accounted for the carbonic acid in the soil moisture.

The fourth soil component was humus, a dark brown or black substance produced by the decay, in the soil air, of dung, turf and other plant remains. Humus was spongy stuff and therefore, in a sandy soil, it was useful in helping to hold moisture. In a clay soil it was useful because it got in between the clay particles, kept them from sticking together and so made the mass more easily workable.

If, then, one wanted to make an enlarged model of a soil one made a mixture of glass marbles and beads of mixed sizes, added some chopped-up pieces of sponge, and moistened the whole with a weak solution of salt.

Regarded from the chemical point of view, one important point was that a soil might be alkaline ("sweet") or acid

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("sour") or neutral (neither sweet nor sour). The reason was that humus was itself an acid, while lime was a base. If acid were allowed to accumulate, the number of kinds of plants that would grow in the soil would become fewer until at last only acid-loving plants, like heather, would grow at all. The way to prevent or to cure acidity was to add lime.

There were two simple tests by which one could get an idea of the sweetness or sourness of the soil. If some strong acid were poured upon it, and it fizzed, then lime (calcium carbonate) was present; if there was no fizzing there was no lime, and either the soil was already sour or might be expected soon to become sour. To find out whether sourness had already developed one shook up the soil with water, and the water was then tested with litmus. Acid turned blue litmus red.

The general idea was that the soil should not be acid and should preferably contain some lime (calcium carbonate)—possibly half of one per cent., or about five tons in an acre of top soil.

This old conception of the structure of the soil is not so very far from the truth if we happen to be dealing with a very sandy type; but it fails to account for the behaviour of a soil containing, as most do, a considerable amount of clay. Clay is known to consist of very small particles, but if one grinds up one's glass beads to a fine glass powder this fails to behave like clay; it does not swell up or get sticky when it is wetted, does not shrink or bind together as it dries, and gives up its water much more readily than clay does. Moreover, there is this further difference: clay has the interesting power of absorbing potash or ammonia from a solution, whereas such a solution passes unchanged through powdered glass. As regards the problem of sourness, it has been found that an ordinary soil may contain no calcium carbonate, may be acid in some degree, and yet may produce very well a wide range of crops.

Nowadays the physical behaviour of clay—its swelling and shrinking, its stickiness when it is wet and its setting hard when it is dried—are explained by saying that it, or some part of it, occurs in the soil as a *colloid*. If we put a grain of salt in water it dissolves and there is, at any stage, an obvious and clear-cut difference between the solid salt and the surrounding salt solution. But we must picture a colloid particle in water as having no such clear-cut surface. It shades

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off by degrees from a solid core to a liquid solution. It must be pictured not like a glass bead in water but rather as a gelatine particle that has been soaking in water for some time. To reconstruct our large-scale model of a soil we should thus have to add some gelatine powder to our mixture of marbles and beads.

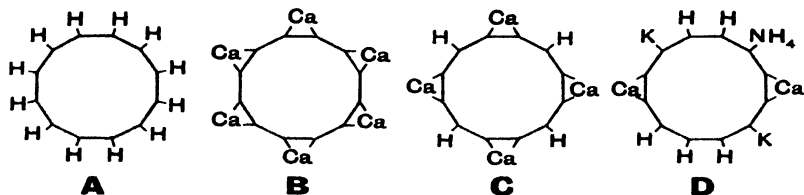
The other essential point is that the clay particle is not chemically inert, like a grain of glass, but can combine, chemically, with hydrogen or alternatively with bases such as calcium (lime) potassium and ammonia. In other words, the clay particle, as well as the humus particle, behaves as what the chemist calls an acid radicle.

An acid radicle may be explained by reference to sulphuric acid and the sulphates. The radicle in this case is composed of sulphur and oxygen atoms and is represented by the symbol $=\text{SO}_4$. Its compound with hydrogen, H_2SO_4 , is sulphuric acid. Calcium sulphate or gypsum (CaSO_4), copper sulphate (CuSO_4) and potassium sulphate (K_2SO_4) are familiar salts in which the hydrogen of the acid has been replaced in each case by a different base. Sulphuric is a strong acid. When it combines with a strong base like lime the resulting salt, calcium sulphate, forms a neutral solution; copper, on the other hand, is a rather weak base and hence a solution of copper sulphate has an acid reaction. Again there is a salt called potassium hydrogen sulphate (KHSO_4) which is half way between sulphuric acid and ordinary potassium sulphate. This salt again, as might be expected, gives an acid solution. Now the clay radicle behaves in the same general manner as the sulphate radicle, combining with hydrogen to form an acid hydrogen clay, or with a base, such as lime, to form calcium clay. It differs from the sulphate radicle in two respects. Firstly, it is a much larger and more complex piece of matter, and can combine with more things at once; secondly its acid is a weak acid, and therefore when it is fully combined with a strong base like lime the resulting calcium clay gives an alkaline reaction to the soil solution. A calcium-hydrogen clay does not necessarily give an acid reaction, but one which will be acid, alkaline or neutral according to the relative proportions of calcium and hydrogen which it contains. As calcium sulphate (gypsum) differs from sodium sulphate (Glauber's salt) so does a calcium clay differ from a sodium clay. The latter is an extremely sticky and impervious substance, and its for-

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mation accounts for the extraordinary change in a clay soil which has been some time under sea water.

The diagram below may perhaps make clear the various conditions in which clay may exist in an ordinary soil:—



A is hydrogen clay. The solution surrounding such a particle will be acid, since acidity is produced by a concentration of hydrogen ions.

B is a fully saturated calcium clay such as might occur in a chalky soil, and which would give an alkaline reaction.

C is a calcium-hydrogen clay which might give a slightly acid, slightly alkaline or neutral reaction according to the exact proportions of calcium and hydrogen which it contained.

D represents a clay particle such as might occur in a fertile soil, containing potassium (K) and ammonium (NH₄) as well as lime and hydrogen. This again might give a slightly acid or slightly alkaline reaction according to the proportion between the hydrogen and the bases.

It will be evident that the reaction of a soil solution may vary from fairly strong acidity to fairly strong alkalinity. In wet climates the bases tend to be washed out, so that soils tend to become acid. In dry climates the bases tend to remain, and soils are generally alkaline.

In order to measure degrees of acidity or alkalinity chemists have devised a scale of hydrogen-ion concentration, called for short the pH scale. The figures run from zero to 14, the zero representing the highest conceivable degree of acidity and the other end the highest imaginable alkalinity. The figure 7, naturally, means neutral.

Chemists are still arguing the question of how acidity or alkalinity affects the plant, and why different plants should be affected in different ways. Meanwhile their scale is very useful because it enables us to measure acidity and to say, with very fair certainty, whether or not a particular soil is too acid or too alkaline to grow a particular crop. It should perhaps be pointed out that mild acidity, in the chemist's sense, does not mean "sourness" in the farmer's sense. "Sourness" may be said to begin at about pH 5.5.

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The hydrogen-ion concentration of a soil solution can be quickly determined, with sufficient accuracy for practical purposes, in the field. This is done by noting the change of colour which the soil solution brings about in certain coloured substances. These substances change colour, as litmus does, but at more precise points on the pH scale.

British soils vary in reaction from about pH 3.8 to pH 8, and each species of crop has a fairly definite "failure point"—a degree of acidity which it cannot bear. The exact "failure point" varies a little with other conditions—rainfall for instance; moreover it is rare to find a field which is uniformly sour. A patchy failure rather than a uniformly bad crop is what is generally seen when a mixed sample of the soil gives a reaction near to the failure point of the crop.

Morley Davies gives the following list of "failure points" for a number of common crops under West-Midland conditions:—

		pH		pH
Red Clover	.. ..	5.5	Swedes and Cabbage	4.9
Sugar-beet	.. ..	5.3	Ryegrass	4.3
Barley	.. ..	5.3	Oats	4.2
Wheat	.. ..	5.1	Potatoes	3.8

Looking at the matter from a slightly different angle, Hendrick and Moore give the following list of what may be called "safety ranges"—the range of soil reaction within which each crop may be expected to make completely satisfactory growth—so long, of course, as other conditions are suitable. It will be noted that, in certain cases, alkalinity as well as severe acidity might prevent fully satisfactory growth.

		pH		pH
Sugar-beet	.. ..	6.0-7.5	Wheat	5.5-7.0
Peas	.. ..	6.0-7.5	Turnips	5.2-6.5
Barley	.. ..	5.7-7.5	Oats	4.5-6.2
Red Clover	.. ..	5.5-7.5	Potatoes	5.0-6.2
Wild White Clover	.. ..	5.5-7.1	Swedes	4.8-6.0

Putting quite broadly the conclusions from these and other similar lists, we may say that a slight degree of acidity is not harmful but actually beneficial; that if we want to grow the whole range of ordinary crops we should aim at keeping our soil reaction about pH 6; and that we may expect no trouble with any common crop (if we exclude lucerne) until parts of our fields fall below pH 5.5. At this stage we may expect patchy failures of red clover, barley and sugar-beet, but we

shall still be able to grow good crops of oats, potatoes, and grass-seeds mixtures, excluding red clover.

Useful as is a knowledge of soil reaction it is unfortunately true that the pH figure, by itself, is no guide to the *quantity* of lime that will be necessary to restore a sour soil to fertile condition—to reduce its acidity say from pH 5 to pH 5.8. The pH value tells us *how acid* the soil colloid is, i.e., how far our colloid is combined with lime and how far with hydrogen. It tells us nothing about the quantity of colloidal material which our lime will have to act upon. A ton of lime per acre might make the desired change in reaction in a sandy soil, whereas four or five tons might be necessary to produce the same change in a peaty clay. An experienced man, dealing with a soil type that he knows, may, from the pH figure alone, be able to make a fairly close estimate of the amount of lime that will be required; but this is all that can be claimed.

The quantity of lime that will be required to produce a desired change in the reaction of a given soil cannot, in fact, be precisely calculated at present. There is, perhaps naturally, a widespread impression that the figure which the chemist gives as the “lime requirement” of a soil indicates the amount of lime that is actually needed to correct the soil’s sourness. But this is far from being true, and the figure should never be taken at its face value. The “lime requirement” of a soil is simply the amount of lime that the soil will absorb from a solution of calcium bicarbonate, under certain conditions. But what a soil can absorb and what it may economically be given, are two different things. The following, from a paper by Morley Davies, emphasizes the point:—

“The ‘lime requirement’ on a red sandy soil of the Bridgnorth series, at pH 6, was 15 cwt. calcium carbonate per acre, while the corresponding figure for a peaty soil proved to be 12 tons calcium carbonate per acre. It is interesting to note that *in neither case was lime necessary for crop growth.*”

The soil chemist, in considering his recommendation about the quantity of lime to be applied in a given instance, takes account of the pH value, of the amount of calcium already present in the soil and of the capacity of the soil to absorb calcium. A very exact calculation is not called for—indeed, there is good reason for applying something more than the

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soil immediately needs; lime is lost in drainage water and there is much to be said for giving a dose large enough to last for a rotation or perhaps longer. There is no particular harm in applying 2 tons an acre where 30 cwt. would satisfy the immediate need. There is, however, a good argument against applying five tons in such circumstances—the point being that the greater the store of lime in the soil the greater will be the loss by drainage. In one of the Harper Adams College trials, plots were dressed at 25, 50 and 100 cwt. per acre respectively and the average annual losses, for the following seven years, were respectively 1, 3, and 6 cwt. per acre.

Moreover, there are circumstances under which excessive liming does positive harm. On certain light soils in Yorkshire, for instance, a slight deficiency causes, as elsewhere, a failure of red clover, but a slight excess induces common scab in the potato crops. In this instance the minimum necessary amount of lime should be given immediately before the clover, and the potato crop should follow only after an interval of two or three years.

The practice of liming is many centuries old, and the continued use of lime is necessary on much of our farm land if this is to be prevented from going back to moorland and heath. At one time and another vast unnecessary expense must have been incurred by unnecessarily heavy doses of lime. To-day there is much land which would benefit, and probably repay, the expense of a properly calculated dressing. The agricultural organizers in all counties have facilities for soil analysis, and it must generally be worth while to seek their advice in the matter.

CROP HUSBANDRY IN THE 18TH CENTURY: HAMPSHIRE AND THE ISLE OF WIGHT

G. E. FUSSELL,

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Hampshire was a county famous in the writings of 18th century topographers for the wealth and variety of its productions. At the date of the first report to the old Board of Agriculture the church lands in the county were let on 21-year leases and leases for lives were common,¹ but nineteen years later leases were getting much into disuse. The north of the county still had extensive wastes between Bagshot and Kingsclere, and the farms were of various sizes, but rather smallish, notwithstanding some engrossing of late years, being still not above £80 rent on the average. In mid-Hants the down farms were large, rented at from £200 to £800, while in Woolmer and Alice Holt Forests they were smaller, ranging between £20 and £300. The occupiers of the smaller farms worked very hard, like day labourers, and lived little better, a commentary on small holdings. In the south-west of the county, farms ranged between £30 and £400 and recent consolidation was complained of. The general statement is that the farms were larger on the chalk and smaller on the clay. In the Isle of Wight many small farms were said to have been consolidated within the last eight or ten years, and rents ranged between £100 and £350, many of the farmers occupying their own freeholds in addition to the land they rented.²

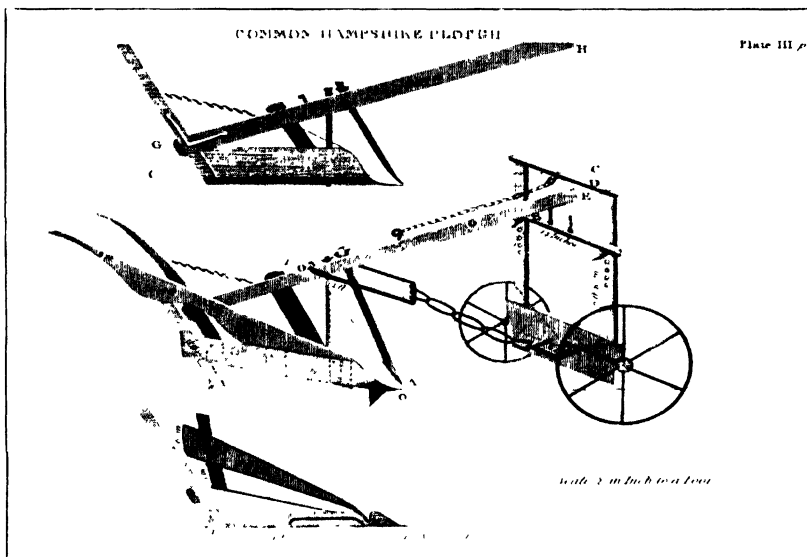
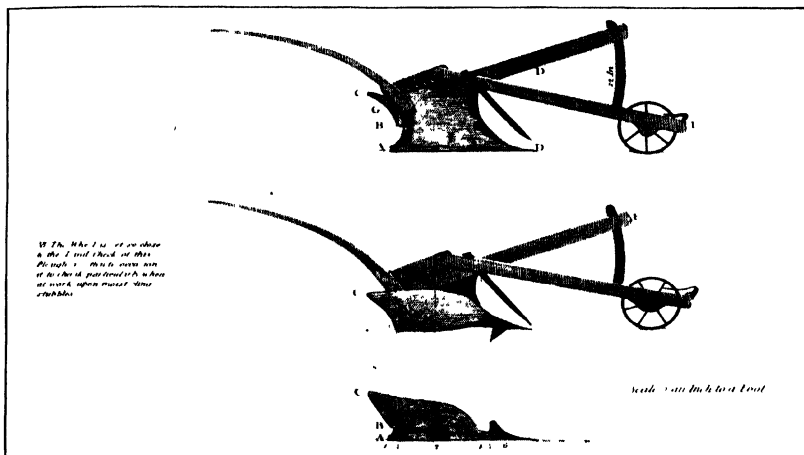
For the early part of the century we have the details left by Edward Lisle, who must have travelled extensively through the county and been well acquainted with many farmers in different parts as well as in Wiltshire, Berkshire and Leicester. An approved rotation was wheat, peas, barley, but wheat, peas, wheat was usual on the clay. The light lands were laid flat on the hills for wheat, but rounded up a little if clay, and the farmers at Crux Easton were in the habit of buying seed from Newbury where it was grown on a white earth to plant in their red. Michaelmas or thereby was the right time to sow, but some farmers on the hills got their wheat in as early as August, in common with similar farmers in Wiltshire and Dorset, especially if the season was wet. The Isle of Wight

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used a course of peas, wheat, barley, and seeding for wheat varied from $2\frac{1}{2}$ to 4 bushels according to the land.³ It was also the practice here, as in Berkshire, to break up the clays with a crop of pease, while a variety of waste products was used for manure. Malt dust was used as in other malting counties, and coal ashes were obtained from the many foundries at Portsmouth for use on the grass land. During the century also the habit of buying dung from Gosport increased, so that instead of getting a gratuity for its removal it cost nine shillings a ton.⁴

Even in the early part of the century a good deal of the downland had been converted from sheep walk to wheat land. This was especially so between Winchester and Salisbury, a distance of some twenty odd miles. Here the sheep made a great impression on Defoe, "But," he says, "'tis more remarkable still; how a great part of these Downs comes by a new Method of Husbandry, to be not only made Arable, which they never were in former Days, but to bear excellent Wheat, and great Crops too, tho' otherwise poor, barren Land, and never known to our Ancestors to be capable of any such Thing; . . . for by only folding the Sheep upon the Plow'd Lands, those Lands, which otherwise are barren, and where the Plow goes within three or four Inches of the solid Rock of Chalk, are made fruitfull . . ." and grew crops of wheat, rye and barley,⁵ but his description of the land between Chertsey, Hartleroe towards Basingstoke is that of a "Black Desert," although before he reached Basingstoke he came to a pleasant fertile country inclosed and cultivated like the rest of England.⁶

Young traversed the district between Salisbury and Romsey in 1768. This was generally inclosed and under a course of fallow, wheat, oats, peas or beans or vetches or a variation. Turnips were grown and folded by sheep. Chalk was laid on the land at twenty loads an acre, and the farms were small, of £20 to £60, a farm of £200, or 150-200 acres being large. On to Winchester the husbandry was the same. Young went to Crux Easton to verify some of Lisle's writings, but could find no memory of oxen being used for ploughing in the parish. Hundred-acre farms were considered large. Round Alton conditions were much the same, but the course was different, being fallow, wheat, barley, clover and trefoil for two years. Vetches were fed off by sheep or cut green for horses. The growth of turnips had much increased lately,



FIGS. 1 and 2. These, together with FIG. 3, show the wide difference in the type of plough used in one county at the end of the eighteenth century.

The Illustrations in this inset are taken from Chas. Vancouver's *General View of the Agriculture of Hampshire and the Isle of Wight* 1810.

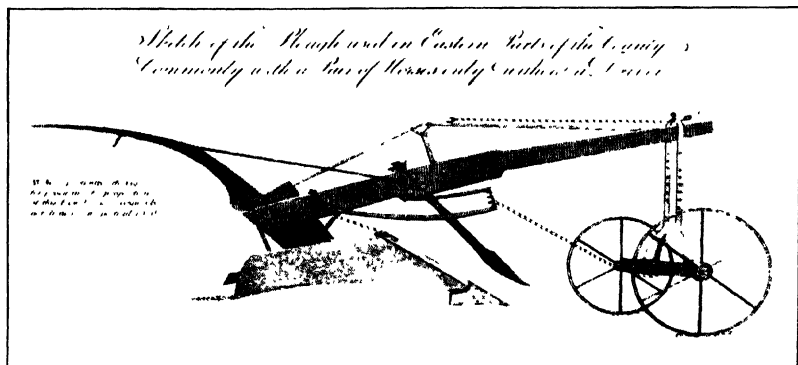


FIG. 3

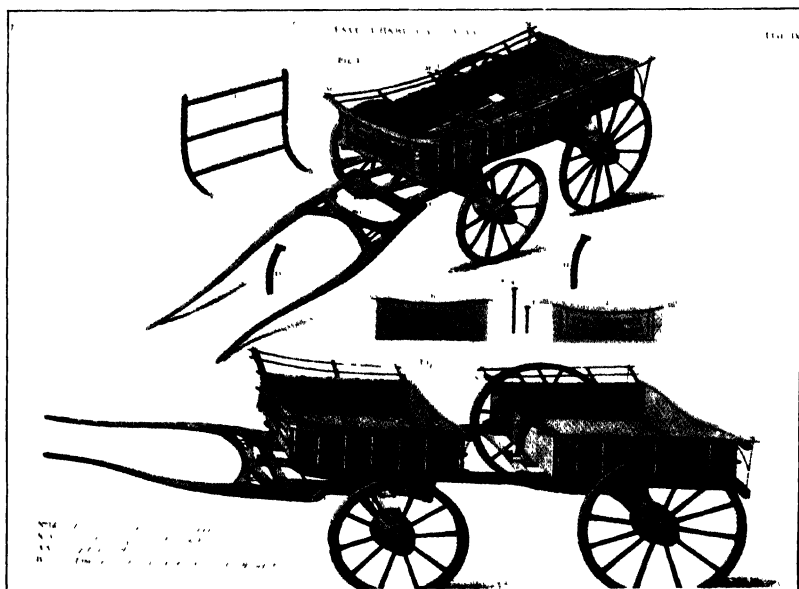


FIG. 4 One of many ingenious patents of the period — of doubtful practical utility

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but wheel ploughs drawn by four horses were still used. Between Alton and Farnham the land was richer, but there was no material difference in the farming until the hop country was reached. The land between Southampton and Winchester, he later found, contained much waste and poor cultivation, with unclosed chalk hills near Winchester, but in the county there were turnips, clover and a good deal of sainfoin, unmistakable signs of an improved husbandry, in his eyes.⁷

Twenty years before this, Dr. Pococke saw the first marl pits of his experience at Beaulieu, although they were scattered throughout the county, and he saw marl mixed with dung used in some places. Apparently marling on newly broken-up grass lands was usual, and the manure was also used on arable here as well as in Surrey and Kent. At some places it was near the surface, and round Selborne, white malm, when turned up by the plough to the frost and rain, mouldered to pieces and became manure itself, bearing good wheat and clover.⁸

The hop gardens were a commonplace of the topographers, and provided employment to the labourers of Selborne, while the women of the parish were employed in picking in September.⁹ These hop gardens were on a narrow strip of land only a quarter of a mile wide, but in a long line ten or twelve miles north of Alton.¹⁰ Another practice in this county which was, however, probably brought to greater perfection in Wiltshire and Dorset, was that of watering meadows when the streams allowed, and the early young grass stimulated by this means was useful for ewes and lambs in the spring.¹¹

The methods of cultivation and the crops grown had not materially changed by the end of the century. Near Basingstoke, wheat, peas, oats or barley with clover was common: sainfoin had been lately introduced both in this district and near Whitchurch. Hops were spreading to the borders of Surrey, but this could not have been a new development:¹² when the sainfoin was worn out it was, as formerly, broken with a breast plough and denshired. Marl and seaweed were used near the coast, but inland, chalk was preferred to marl and gypsum was sometimes used as a top dressing for grass land. Rye was grown as a crop in the Valley of the Avon and Christchurch, but elsewhere only as spring feed for sheep: green manuring was used by two farmers, one of whom lived in the Isle of Wight.¹³ The plough mainly in use

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was a very heavy two-wheel plough like that of Wiltshire, Sussex and Surrey, but an iron plough with a cast iron share and a wooden beam and handle invented by Mr. Sparks was used in the south of the county. Plenty's patent plough, an improved turnwrest, and in the woodlands a mole draining plough had also been used by 1813. Other ploughs had also been introduced; harrows and cultivators and various different rollers were used, while drills were then used by gentlemen and some intelligent broadcast farmers occasionally, and threshing "mills" had found their way into many parts of the county. The wagons and carts were useful, and one type was a patent.¹⁴ It must not be forgotten, of course, that there were still extensive wastes in the county as there are to-day.

The farming of the Isle of Wight met with great approbation from the topographers, who perpetuated a legend that it produced enough corn in one year to feed its population for seven, and so was able to export large quantities. Lisle, indeed, tells us that the farmers of the Island sometimes chalked their lands to the rate of 25 loads to the acre in his day.¹⁵ In the neighbourhood of Ryde this had been increased to thirty loads by Young's day, and he reports that improved courses had been adopted throughout the island. Paring and burning had been abandoned here by 1771, and lime had given place to what was perhaps the older chalk. Tares were grown for soiling horses, only one ox team was seen and all the ploughs were four-horse wheel ploughs. Perhaps the improvements were a natural outcome of the adaptability of the people and perhaps they owed something to the prevalence of leases.¹⁶ There were different rotations, one being fallow, wheat, barley, clover and ray grass, wheat on one earth; another was turnips, barley, clover and ray grass, wheat, barley or oats, and there were variations of these, the yields of cereals certainly being heavier than the average of other counties, if we can accept a contemporary estimate.¹⁷ Nine years later, the strong lands were given a complete fallow and dung for wheat, while the freer earths and sands were used for turnips. Drilling was practised by many farmers, cabbages were grown on a large scale, carrots were reviving, potatoes were increasing, and hollow draining with stones was practised on the arable.¹⁸ This seems to have become the standard of farming in the Island; the county reporter tells us much the same as does Marshall, although the former states there were not many potatoes, and the latter's statement that there was

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not sainfoin cannot be reconciled with Young's direct contradiction, although he lays no emphasis on the crop.¹⁹

REFERENCES

- ¹ A. and W. Driver : *Report*, 1794, p. 21. See also Taylor : *Decline* . . . , p. 38. Ernle : p. 293.—² Chas. Vancouver : *Report*, 1813, pp. 55, 65, 75, 76, 78, 81, 83, 85.—³ Edward Lisle : *Observations* . . . , 2nd ed., 1757, pp. 132, 152 ff., 164, 165, 167 ff., 175, 177. John Mills : *New System* . . . , 1767, p. 360 ff.—⁴ Switzer : *Iconographia*, 1718, pp. 183, 193. *Annals*, IX (1788), p. 219. VII (1786), p. 392.—⁵ *Tour* : 1724 ; Letter II, p. 26. See also *Annals*, XXIII (1795), p. 356, where the farming is not considered good.—⁶ *Ibid.*, p. 14.—⁷ *Six Weeks' Tour*, 1768, pp. 167–181. *Eastern Tour*, 1771, III, pp. 202–241. As to sainfoin in Hants, Wilts, and Berks, see Kent : *Hints* . . . , 1775, p. 39.—⁸ *Dr. Pococke's Journey*, 1750, I, p. 82. Ellis : *Modern Husbandry*, 1750, III, May, p. 67. White : *Selborne*, p. 4.—⁹ Laurence : *New System*, 1726, p. 109 ff. White : *op. cit.*, p. 15.—¹⁰ Marshall : *Southern Counties*, 1798, II, pp. 48 ff.—¹¹ Kent : *Hints* . . . , 1775, p. 53. Marshall : *ibid.*, p. 331.—¹² Defoe : *Tour*, 5th ed., 1753, I, p. 214.—¹³ Marshall : *ibid.*, pp. 320–329. A. and W. Driver : *Report*, 1794, pp. 11–16, 19. Chas. Vancouver : *Report*, 1813, pp. 157, 193, 200, 336, 345, 347. See also Cruttwell : *Tour*, 1801, p. lxxxvii.—¹⁴ Driver : *ibid.*, p. 18. Vancouver : *ibid.*, pp. 92–105.—¹⁵ *Observations* . . . , 2nd ed., 1757, p. 64. See for continuance of this practice Thos. Pennant : *A journey from London to the Isle of Wight*, 1801, II, p. 167.—¹⁶ *Eastern Tour*, III, pp. 178–195.—¹⁷ Agricola Sylvan : *Farmer's Magazine*, IV (1779), p. 104 ff.—¹⁸ *Annals*, IX (1788), p. 41 ff.—¹⁹ Rev. Warner : *Report*, 1794, pp. 49–52. Marshall : *ibid.*, pp. 267–280. Young : *ibid.*, p. 190.

COUNCIL OF AGRICULTURE FOR ENGLAND

The 52nd meeting of the Council of Agriculture for England was held at the Middlesex Guildhall, Westminster, on June 16, 1939, Professor Arthur W. Ashby, who was elected Chairman for the current year, being in the Chair. Lord Cranworth, the retiring Chairman, was thanked for his services during his period of office. The Minister, Sir Reginald Dorman-Smith, M.P.; the Parliamentary Secretary, the Earl of Feversham; and the Permanent Secretary, Sir Donald Fergusson, K.C.B., were present.

Price-Insurance for Sheep, Barley and Oats. Sir Arthur Hazlerigg, Bt. (Leicester), moved the adoption of the Standing Committee's report on the Government proposals for price-insurance for sheep, barley and oats. Lord Hastings, Lord Eltisley, Mr. W. W. Sampson (Dorset), Mr. F. J. Jenkinson (Kesteven), Mr. A. Symonds (West Suffolk), Mr. E. L. Pledger (Essex) and Mr. Walter Smith took part in the discussion, and Lord Feversham and Sir Donald Fergusson spoke on behalf of the Ministry. The report was adopted as submitted (see Appendix I).

Address by the Minister. Sir Reginald Dorman-Smith, in the course of his address, referred to the fact that he himself had been a member of the Council. He knew that the Council would not wish him to go into any great detail on the subject of its principal report, as only yesterday he had dealt with the second reading of the Agricultural Development Bill which concerned itself with the same subjects. His predecessor, Mr. Morrison, had announced at the last Council meeting (Dec., 1938) that the whole agricultural situation had been under review from the point of view of necessary changes in policy, and that, at that time, certain of them were being worked out. There had since been discussions with organized bodies, such as the National Farmers' Union, the Transport and General Workers' Union, the Central Land-owners' Association and with the Standing Committee of the Council, and he took this opportunity of expressing his most sincere thanks for the advice and assistance which had been given him. He also paid a warm tribute to the work of his predecessor, Mr. Morrison, which had made possible the contribution set out in the Agricultural Development Bill. He could not expect all farmers to be satisfied with the measure

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of the progress marked by the new Bill, though he himself would be satisfied to obtain that progress and consolidate the position. Neither would he minimize the task ahead, as it was one which involved re-adjustment of the nation's economic life in certain respects. We had developed as a great industrial country and there was still a sad lack of balance between Industry and Agriculture. Only a few years ago, the then Chancellor of the Exchequer had been constrained to point out that the widespread depression then with us had been of very great severity because we had built a heavy top structure of Industry upon too narrow a basis of Agriculture. Dealing with agricultural labour, the Minister pointed out the essential difference between labour in farming and labour in other industries; the manufacturer could curtail his business in bad times, standing off some of his workmen for a period, but the farmer, with a different kind of organization, could not, generally speaking, adopt the same methods. This difference made it essential for the farm worker and the farmer to be assisted in their task.

He understood that the question of the limitation of the number of sheep to 27 million in the new Bill had come up in earlier discussion at this meeting. That figure had been exceeded only four times in the last 40 years. It might not frequently be exceeded in the future. It might well be that there would be a change in the type of sheep grown in this country in response to the market demand for smaller joints. Our competitors overseas had produced a smaller sheep which suited our public's requirements in this respect. Farmers would be able to adapt themselves to meet such new requirements if they were given some security which would enable them to plan ahead. He hoped that the proposals in the Bill for price-insurance for sheep at 10*d.* per pound, coupled with regulation of imports from overseas, would give that security.

The Minister then dealt with the measures being taken to increase fertility through the supplies of lime and slag. He thanked the Land Fertility Committee for its work, which up to April last accounted for 385,000 contributions to farmers amounting to over £2,000,000. He paid a tribute to the County Agricultural Organizers and their staffs for the work they were doing in connexion with the ploughing-up campaign. Up to date, arrangements had already been made to plough up about one-half of the acreage he had expected would be ploughed up before the end of this year's allowed period.

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He referred to the new Poultry Bill, and said that he was anxious to push ahead with it as quickly as possible.

As regards emergency plans, he had interviewed the Chairmen designate of the County War Agricultural Committees and had also made an advance with regard to the recruitment of a Woman's Land Army for supplementary help on the land in case of emergency. Tractors and reserves of other machinery, as well as people capable of dealing with them, were also being arranged for.

Summing up, Sir Reginald said that the four months past had been months of intense activity at the Ministry. Besides the legislation he had mentioned, the Wheat Amendment Bill had been introduced. The question of processed milk had also been tackled, and an Order would be tabled in the House of Commons for the regulation of future supplies. The Attested herds now in England and Wales numbered 5,400 and 1,700 in Scotland, making 7,100 altogether.

He ended his survey with a brief comparison of the wages and conditions of the agricultural worker with those of the industrial worker in the towns. The essential thing, he said, was that the agricultural industry should be put in a position to pay its workers the wages they should have, and the Government were already doing what they could to assist, and helping also as regards improved conditions in housing, water supply, and electricity. It was necessary to find the right relation between urban and rural life. This he hoped, with the Council's aid, to do and to establish it in this country on a permanent basis.

On the motion of Sir Merrik Burrell, Bart., the Minister was heartily thanked for his address.

Poultry Industry Bill.—Mr. W. J. Cumber (Berks.) moved the adoption of the Standing Committee's Report on the Poultry Industry Bill (see Appendix II). Sir Merrik Burrell, Mr. W. B. Pinching (Middlesex) spoke on the motion. The Report was adopted.

Field Drainage and Ploughing-up Policy.—Major Nelson Rooke moved :

"That appreciating the great importance of the Government's further measure to help home production by the payment of grants of £2 per acre towards ploughing-up indifferent permanent pastures, the Council of Agriculture strongly recommends the Government to ensure the fullest possible benefits from this policy by a scheme of grants or special loans on easy terms for the field drainage of land subject to water-logging."

Mr. S. Wallace (Herts.) seconded the motion, which was spoken to by Mr. A. Pearce, Mr. A. E. Bryant (Bucks.), Lord Hastings, Mr. W. H. Turner (West Riding), Mr. R. Anderson (Northumberland), Mr. C. H.

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Roberts (Cumberland), Mr. R. L. Walker (West Riding), and Lord Feversham spoke on behalf of the Ministry. Major Rooke replied to the discussion. The Chairman said that the matter would be considered by the Standing Committee. The motion was then put to the Meeting and carried.

McCreagh Estate.—Mr. H. W. Thomas moved :

“ That, in view of the importance of getting as much land as possible in a reasonably good state of cultivation, this Council respectfully asks the Minister to take action with regard to the McCreagh Estate in Hampshire.”

Mr. C. H. Roberts (Cumberland) seconded the motion, and Sir Donald Fergusson spoke on behalf of the Ministry. The resolution was carried.

Housing the Rural Workers.—Major Rea moved :

“ That this Council respectfully requests that the Ministry of Health be asked to take all possible steps to see that Local Authorities administer the Housing (Financial Provisions) Act, 1938, so that full advantage may be taken of the scheme.”

He said that he wished the motion to refer also to the Housing (Rural Workers) Act.

Mr. C. H. Roberts seconded the motion, which was spoken to by Mr. E. G. Gooch, Mr. W. W. Sampson (Dorset), Mr. Walter Smith and Mr. R. Anderson (Northumberland). It was finally agreed, on the Chairman's suggestion and to meet the divergence of opinion that was revealed in the discussion, to consider two resolutions, in the same terms, except that one should refer to the Housing (Financial Provisions) Act, 1938, and the other to the Housing (Rural Workers) Acts. Both resolutions were put to the Meeting and carried.

APPENDIXES—REPORTS OF THE STANDING COMMITTEE

I. Price Insurance for Sheep, Barley and Oats

1. The Council will no doubt wish the Standing Committee to report its views on the subject of the instalment of the Government's long-term agricultural policy which is included in the recently announced “ price insurance ” schemes for sheep, barley and oats. The Committee cordially welcomes the instalment. It is a considerable step in the direction of providing suitable price safeguards to those sections of the industry that need them as a bulwark against such severe losses as have been sustained by primary producers in recent years through the falling away of prices due to adverse world economic conditions. It hopes that the complex machinery devised for use in the case of sheep will not put too great a strain upon the industry for what may be little or no return by way of price subsidy during the majority of years. The Committee, however, sees no practical alternative plan to give the necessary safeguard, whilst the economic structure of the industry remains as it is at present. As regards the proposals for oats and, to some extent, for barley, these are in the nature of improvements in the amounts of subsidies already approved by Parliament in the Agriculture Act, 1937.

2. It may be useful for the Council to have a brief statement of the proposals. They are, as regards sheep, that sheep-farmers should be reimbursed to the extent that the price of sheep and lambs exceeding a prescribed minimum weight (excluding ewes and rams) falls below a

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standard average price of 10*d.* a pound for the year; but that payment where it becomes due should be made monthly according to a plan following the normal seasonal variations of price, i.e., there shall be monthly *standard* average prices which will build up to 10*d.* a pound for the year, and monthly *actual* average prices, and payments of subsidy will be made according to the difference between them. This guaranteed average price of 10*d.* will be related to a sheep population of 27 millions and will be subject to reduction if numbers go above that figure. The Government will also control imports of mutton and lamb in order to help stabilise the market. If the standard price should be in excess of the market price for two successive years, the standard price would be scaled down subject to a review of all relevant factors, including imports.

3. As regards barley, discussions are now proceeding with the industries which use barley for malting, in order to decide what part these industries can play in a long-term scheme. In the meantime, and for the 1938 crop, the Government has decided that growers will no longer be debarred, as they are now, from receiving both deficiency payments for their wheat and assistance for their barley, where they grow both crops. That is to say, those who are receiving wheat payments will be eligible for barley subsidy at 13*s.* 6*d.* an acre, and those who are not, will receive 20*s.* 8*d.* an acre in addition to the 10*s.* 10*d.* already paid to them, making 31*s.* 6*d.* in all.

4. As regards oats, this crop will be in the same position as regards deficiency payments for wheat as will be barley, and this new arrangement will be applied not only retrospectively to last year's crop but to future crops as well. The rate of subsidy per acre will be increased where growers do *not* receive wheat payments by calculation on the basis of 14 cwt. per acre instead of 6 cwt. as at present. On the 1938 crop, these growers would receive 18*s.* 4*d.* an acre in addition to the 13*s.* 2*d.* they have already been paid under the existing scheme, making 31*s.* 6*d.* an acre in all. Growers who *do* receive wheat payments will be eligible for oats subsidy on the basis of 6 cwt. an acre, and for their 1938 crop this sum will amount to 13*s.* 6*d.* an acre.

5. The Committee feels sure that these proposals for the Government's long-term policy will, when fully worked out in detail and translated into law, give a definite and welcome measure of safeguard to the farmers who are affected by them. The Council will doubtless wish to express its appreciation of the Minister's action in bringing forward this considerable instalment of Government agricultural policy at one time.

6. The Council would perhaps desire the Committee also to refer to the Minister's proposal to give, as a special temporary measure, grants of £2 an acre for ploughing up and re-seeding some of the poorer permanent pasture, with a view to increasing its fertility, and to use it for arable cultivation, if that comes to be required. The Committee is certain that farmers who are in a position to get land ready for cropping in this way will do it more quickly and thoroughly after this lead given them by the Government. The proposed grants should prove a welcome contribution to their costs. In order to qualify for grants, farmers will be required to satisfy the Ministry that the land ploughed up—

(a) has been under grass for at least the last 7 years;

(b) has been, or is being, brought into a state of cleanliness and fertility by approved methods such as by fallowing, by direct re-seeding, or, subject to the approval of the Ministry, by taking a suitable catch crop during the present year, *e.g.* mustard, vetches, rape, kale, turnips, buckwheat, and mixtures of rye grasses and clovers;

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- (c) is land that will be likely to benefit by such cultivation with a view to re-seeding or re-introduction into a suitable rotation, and would be likely, if the need were to arise, to produce satisfactory arable crops for harvesting in 1940.

Such ploughing is intended to be over and above the normal rotation ploughing of the farm; and farmers—who are themselves usually the best judges of any pasture they have that may be suitable for this operation—will not overlook the question of applying suitable fertilizers and lime, in connexion with which the facilities under the Land Fertility Scheme for the supply of cheap lime and basic slag will, of course, be available. Where farmers are in doubt as to the suitability of land for ploughing up and re-seeding, or as to the most appropriate seeds mixtures to use, they should consult their County Agricultural Organiser. Application should be made to the Ministry at 80, Leonard Street, E.C.2, for permission to plough up such grassland, but once the Ministry has been notified there is no need to delay in proceeding with the proposed work where farmers are certain that they will be able to satisfy the conditions. One minor suggestion, but still of importance in connection with the ploughing-up campaign, is that the Government might, if it has not already done so, ask seedsmen to do whatever is possible to keep down the price of suitable grass-seed mixtures to farmers—in the same way that lime and basic-slag prices are kept down in connection with the lime and basic-slag scheme. The Council feels that all seed merchants of reputation and standing will readily co-operate in this matter in the national interest, if asked to do so.

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II. Poultry Industry Bill

1. As the Council is aware, the question of the improvement of the Poultry Industry is one as to which the Standing Committee has, from time to time, furnished reports to it. These have been concerned with one or other of the many aspects of the Industry, and it is hoped have proved useful to the Government. To-day, the Committee is glad to welcome and to recommend to the Council the Government's new Poultry Industry Bill. It welcomes it because of the dire need of the Industry, having regard to the many dangers which threaten the survival of so many individuals as poultry-keepers; and it recommends it because the Bill offers to deal thoroughly and wholeheartedly with the whole existing situation.

2. The Committee proposes briefly to explain the Bill and to comment on one or two matters arising, which it hopes the Council will agree should form the subject of minor representation to the Government.

3. The two outstanding needs of the Industry at the present time are the elimination of disease and the improvement of marketing. The first of these was strongly emphasized by the Poultry Technical Committee reporting in January, 1938, and the second has been considered in many aspects both as to poultry and eggs in the reports of Reorganisation Commissions under the Agricultural Marketing Acts, whose recommendations, however, for setting up Marketing Boards have not been adopted by the producers. It is not necessary here to go into the reasons for the action or lack of action by producers in this respect, but those in touch with the Industry are well aware of the difficulties of obtaining agreement amongst so many diverse interests as are concerned.

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4. Both the health of stock and the marketing of poultry and poultry products are well covered in the Bill, which, however, deals with other important matters as well. The early clauses provide for the constitution of a Poultry Commission, whose business it will be to deal with questions relating to the health and quality of the poultry stock and eggs for hatching, and the production, marketing, and consumption of poultry and poultry products.

5. On the stock improvement side, the Bill makes provision for the registration of all persons supplying fowls for stock purposes or eggs for hatching, and for regulations to be made, amongst other things, for preventing the use of unsuitable fowls for breeding purposes and for requiring the notification of disease. The distribution of stock or eggs for hatching from premises at which disease exists or where the breeding stock is unsuitable may be prohibited by the Commission. Further clauses deal with other aspects of the improvement of the quality of stock. This object will be encouraged by Exchequer grants amounting in the aggregate up to £250,000 during 7 years to be spent in premiums to those breeders who adopt the higher standards that will be required under what will be known as an "Accreditation Scheme." These premiums will be given during the period mentioned in diminishing amounts. A Stock Improvement Advisory Committee will be appointed to assist the Poultry Commission generally in respect of stock improvement matters.

6. As regards marketing, the provisions are designed to secure that, as from an appointed day when the machinery is ready, home-produced eggs and poultry shall be graded and marked to show the grade when they are sold to the consumer. The Bill places the general responsibility for grading on the wholesale trade, and, in order to ensure that eggs and poultry reach the retailer properly graded and described, wholesalers will be required to be registered and to observe regulations fitted to the circumstances of their own particular branch of the trade. Certain forms of sale are, however, excluded from the requirement of grading. For example, producers of eggs and poultry who merely sell by wholesale their own products will not be subject to grading requirements, and sales by the hotel and restaurant trades are also exempt. A general power is also given to the Commission to grant further exemptions. A Marketing Advisory Committee will be appointed to assist the Poultry Commission with advice on marketing matters.

7. It will be observed that, generally speaking, the ordinary producers of poultry and eggs for sale will not be subject to requirements to grade their products, this being the responsibility of the distributing interests. At the same time, the channels of supply to them of raw materials in the shape of breeding stock, hatching eggs, and day-old chicks, will be cleaned and purified through the action of the provisions as to health of stock.

8. As regards preserved eggs, there will be power to require that they be marked as such in addition to carrying their grade marks. Imported preserved eggs will also be required to be marked as such.

9. The Board of Trade will be empowered to regulate imports of poultry and poultry products, if such a course is necessary to secure the stability of the markets, by Order which will be subject to the affirmative approval of Parliament.

10. As a further aid to the well-being of the Industry so transformed, the Bill permits the making of service schemes for such purposes as insurance, publicity, storing of surpluses, research, and the provision of marketing intelligence.

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11. In addition, a sum not exceeding £50,000 will be provided for loans to Producers' Co-operative Egg and Poultry Packing Stations and for grants for demonstrations of poultry-packing.

12. It will be seen from this summary that all sides of a comprehensive scheme for the Industry are proposed to be built up squarely, and with it the Industry should find itself, as the improvements become effective, fully relieved of the present heavy drags and impediments in the way of its progress. The Committee feels sure that if the Industry now applies itself to working the measure proposed, and puts on one side considerations of small sectional interests in order to obtain more surely the large general advantages offered by the Bill, it will soon rehabilitate itself and become a thriving Industry in place of one which has lately suffered from accumulating difficulties and depression. Particularly do we think that the home table poultry industry could and should be speedily built up. We have expressed this view before, and we feel strongly that there is no justification for the large imports of poultry meat while we can satisfy our home demand from home production. But home production must be made to compete with, and beat, imports, both in quality and price. Of the two, we venture to think, in view of the luxury character of much of the present trade, that quality is the more important factor in the first instance. There should be no insuperable difficulty in the way of the supply by our producers of table poultry of the best that can be anywhere obtained and in sufficient quantity to satisfy all demands. It requires knowledge and organisation of the Industry, and these, no doubt, the Poultry Commission will be quick to see applied to the problem. The purchase of good quality home-produced in place of imported should, with added supplies, create a position in which the public would at last be able to look on poultry as a regular alternative dish instead of one more or less reserved for special occasions.

13. In conclusion, the Committee desires to call attention once again to the anomaly by which, under the laws that are designed to prevent it, imported poultry, particularly turkeys, are still sold—possibly in some cases inadvertently—as English. The regulations require imported birds to be marked with a disc. The disc is required to be placed in the wing, and the information of the Committee is that it may easily be jagged off in the plucking or otherwise removed before sale to the public. There have been many cases of prosecution on account of the absence of the disc in retail sales, where turkeys are known to be imported, but the penalties inflicted and the publicity obtained are not sufficient to improve the position. It is admitted that the Trade does not appear to be alarmed at the position; that the home producer has, so far, made no appeal for proper safeguarding against unfair competition; and that consumers do not ask to see whether there is any sign of a disc having been removed when they buy English poultry. It is admitted also that the matter can be set right under the procedure of the Merchandise Marks Act, 1926, on an application of those interested. But the Committee feels that there are reasons why the matter should be exceptionally dealt with under the present comprehensive measure for the poultry industry. The marketing of imported stored eggs is being dealt with in the Bill, as also is the subject of penalties for removing marks from imported eggs. If the Bill can be brought to cover these matters, the Committee considers that the question of the marking of imported poultry might also be brought in. If the position is allowed to remain, the Committee sees no alternative but for criminal carelessness or even fraud to continue in many cases unchecked because of the deference which is paid to existing but unsuitable legislation.

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Colorado Beetle

The Ministry desires again to draw the attention of all potato growers to the increasing danger of the Colorado Beetle reaching this country, either by flight or by other means. The situation on the Continent in 1938 was the most serious in any year since the pest was first discovered in France. The Colorado Beetle now exists also in Germany, Switzerland and Luxemburg; migratory flights from France have taken place over Belgium and reached Holland and, given favourable climatic conditions, the direct invasion of this country by similar means is well within the bounds of possibility.

The success of measures undertaken for the eradication of the pest should it arrive here will depend on their being carried out in good time. The Ministry is accordingly anxious to obtain as early notification as possible of the discovery of the pest in this country. Potato growers, including private gardeners and allotment holders, particularly those in coastal districts, are asked to keep a close watch on their crops throughout the present season and to inform the Ministry as soon as they discover or suspect the presence of the Beetle, a full description of which is given in the Ministry's Advisory Leaflet No. 71. A single colony in a private kitchen garden, allotment, or potato field, which escapes detection may result in a widespread outbreak which might prove extremely difficult to eradicate.

Any yellowish beetle about $\frac{1}{2}$ in. long, with black stripes (running "up and down" the beetle—not "across") or any red or reddish-yellow grub, that is found feeding upon potato leaves should be regarded with suspicion. When suspected Colorado Beetles or grubs are discovered, specimens should be placed in a tin box (in which no holes should be punched) with a piece of potato leaf, and the box should be sent to the Ministry, 10, Whitehall Place, London, S.W.1, with a letter stating the exact place where the insects were caught and the name and address of the finder. No other steps should be

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taken until instructions are received from the Ministry; it is especially important that the crop should not be sprayed, except under authority of the Ministry, or be interfered with in any way, as unauthorized spraying or treatment may cause the beetles to spread, and an outbreak possibly affecting only two or three square yards may be distributed throughout the field or even beyond it.

The object of these measures is to keep the insect confined to as small an area as possible, so that it may be eradicated without loss of time.

Fumigation of Agricultural and Horticultural Buildings

The Ministry desires to call attention to the Hydrogen Cyanide (Fumigation of Buildings) Regulations of 1938 which have been made by the Secretary of State for Home Affairs under Section 1 of the Hydrogen Cyanide (Fumigation) Act of 1937, and which came into force on February 1, 1939.

The effect of the regulations is to prohibit, except in accordance with the prescribed conditions, the fumigation with hydrogen cyanide of premises, including agricultural and horticultural buildings if forming part of, or attached to a dwelling house, e.g., a conservatory attached to or leading out of a house, or a farm granary or similar store attached to a farm house.

Fumigation carried out in a building or part of a building specially constructed or adapted for the purpose is exempt from the regulations, as is also the fumigation of agricultural or horticultural buildings which do not form part of a dwelling house.

Home-Grown Feeding Stuffs

For some years the Ministry has issued a bulletin, entitled *Home-Grown Feeding Stuffs*,* which contains advice as to the best means of profitably using home-grown produce. In normal circumstances this is generally a matter of costs, i.e., whether it is advantageous, at current market prices, to sell home-grown produce and purchase oil cakes and the like, or *vice versa*. Purchased foodstuffs, however, come largely from overseas and the position may arise where such imports are available only in much reduced quantity and at increased

* Bulletin No. 13, *Home-Grown Feeding Stuffs*, 2nd, re-written edition. Obtainable through a bookseller or from H.M. Stationery Office. Price, 1s. (post free 1s. 2d.).

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prices. The peril is that the ordinary farmer may almost have forgotten how home-grown produce can be used to make up efficient rations for milk production and feeding generally. Dr. Woodman, the author of the bulletin, has therefore prepared a revised and much enlarged edition in which, while dealing adequately with the use of home-grown foods under normal conditions, he has devoted considerable attention to possible changed circumstances.

It is, of course, true that much of the produce grown on the farm is of a carbohydrate-rich nature, but the author demonstrates that a large proportion of the protein required by farm animals can be supplied by grass and forage crops home produced. The use of peas and beans as providers of protein is generally well known.

It is hoped that the new edition will be of practical value to dairy farmers and feeders generally, particularly at the present juncture.

Marketing Notes

Regulation of Imports of Processed Milks. Under the provisions of Section 1 of the Agricultural Marketing Act, 1933, the Board of Trade have made the *Processed Milk (Import Regulation) Order, 1939*,* which provides that no processed milk shall be imported into the United Kingdom unless there is produced at the time of importation:—

(a) a licence issued by the Board of Trade, or

(b) a certificate in a form approved by the Board of Trade.

The Order, which came into operation on June 19, 1939, applies to imports, from all sources, of condensed whole milk, condensed skimmed milk, full cream milk powder, skimmed milk powder, buttermilk powder, whey powder and cream, and replaces the voluntary arrangements previously in force with the foreign supplying countries for the limitation of their imports into this country.

Livestock Industry Act, 1937: Livestock Advisory Committee. The Minister of Agriculture and Fisheries, Secretary of State for Scotland, and Secretary of State for the Home Department, have appointed Mr. John Henderson to the Livestock Advisory Committee as a member representative of the Association of County Councils in Scotland. He will take the place of Captain R. J. Thomson who has resigned.

* H.M. Stationery Office. Price 1d.

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Sheep Subsidy Scheme Advisory Committee. This Committee has been appointed by the Livestock Commission to advise the Commission on the preparation of a detailed scheme for giving effect to the provisions of Part III of the Agricultural Development Bill presented to the House of Commons on June 6. Lt.-Col. Sir John Chancellor, G.C.M.G., G.C.V.O., D.S.O., Chairman of the Commission, will be Chairman of the Committee, and Mr. F. A. Hainsworth has been appointed to be Secretary.

National Mark Publicity. On June 1, the Minister opened the National Mark exhibition at Charing Cross Underground Station. This exhibition, which took the form of a descriptive diorama illustrating the development of the National Mark movement, has received very high praise and is stated to have been the best exhibition of its kind ever staged on that site.

Marketing Demonstrations. Particulars of exhibits and demonstrations to be staged by the Ministry during July are as follows :—

<i>Show</i>	<i>Programme</i>
Aldershot, June 29-July 1	National Mark Exhibit and Egg Grading Demonstration.
R.A.S.E., Windsor Great Park, July 4-8	Education, Research and Marketing, Cinema.
Great Yorkshire, Halifax, 12-14 July	National Mark Exhibit and Cattle.
Kent County — Folkestone, July 12-14	Education and Marketing Exhibit, Cinema.
Northumberland Agricultural Show, Newcastle-on-Tyne, July 18-20	National Mark Exhibit arranged in conjunction with the County Federation of Women's Institutes.
Royal Welsh — Caernarvon, 26-28 July	Education, Research and Marketing, Cinema.

Wheat Sampling Observations

The quarterly statements relating to the above scheme will not in future be published in this JOURNAL. It is understood that arrangements have been made to incorporate them in an annual report, which will be published in the January issue of the *Empire Journal of Experimental Agriculture*.

PRICES OF ARTIFICIAL MANURES

Description	Average prices per ton (2,240 lb.) during week ended June 14				
	Bristol	Hull	L'pool.	London	Costs per Unit¶
Nitrate of Soda (N. 15½%) ..	£ 8 0c	£ 8 0c	£ 8 0c	£ 8 0c	5. d.
„ „ Granulated (N. 16%) ..	8 0c	8 0c	8 0c	8 0c	10 4
Nitrate of Lime (N. 13%) ..	7 7e	7 7e	7 7e	7 7e	11 4
Nitro-Chalk (N. 15½%) ..	7 10c	7 10c	7 10c	7 10c	9 9
Sulphate of Ammonia :—					
Neutral (N. 20·6%) ..	7 14c	7 14c	7 14c	7 14c	7 6
Calcium Cyanamide (N. 20·6%) ..	7 19d	7 19d	7 19d	7 19d	7 8
Kainite (Pot. 14%) ..	2 18	2 15	2 15	2 15	3 11
Potash Salts (Pot. 30%) ..	5 4	5 1	5 0	5 1	3 5
„ „ (Pot. 20%) ..	3 15	3 12	3 12	3 12	3 7
Muriate of Potash (Pot. 50%) ..	8 10	8 8	8 5	8 8	3 4
Sulphate (Pot. 48%) ..	10 2	10 0	9 17	10 0	4 2
Basic Slag (P.A. 15½%) ..	2 12b	2 5b	—	2 10b	3 2
„ „ (P.A. 14%) ..	2 8b	2 0b	2 0b	2 0b	3 3
Grd. Rock Phosphate (P.A. 26-27½%) ..	3 5a	3 0a	2 15a	2 10a	1 10
Superphosphate (S.P.A. 16%) ..	3 6h	—	3 2f	2 19g	3 9
„ „ (S.P.A. 13½%) ..	—	—	2 19f	2 16g	4 1
Bone Meal (N. 3½%, P.A. 20½%) ..	—	7 5	6 17h	6 12	—
Steamed Bone Flour (N. ½%, P.A. 27½-29½%) ..	4 15i	4 15	4 15h	4 10	—

Abbreviations : N. = Nitrogen ; P.A. = Phosphoric Acid ;
S.P.A. = Soluble Phosphoric Acid ; Pot. = Potash.

* Prices are for not less than 6-ton lots at purchaser's nearest railway station unless otherwise stated. Unit values are calculated on carriage-paid prices.

§ Prices are for not less than 2-ton lots, nett cash for prompt delivery, f.o.r., in town named, unless otherwise stated. Unit values are calculated on f.o.r. prices.

a Prices for 4-ton lots f.o.r. Fineness 85% through standard sieve.

b Prices for 6-ton lots. Prices at Bristol are f.o.r. Bridgwater ; at Hull and Liverpool f.o.r. neighbouring works and at London f.o.r. at depots in London districts. Fineness 80% through standard sieve.

c For lots of 4 tons and under 6 tons the price is 1s. per ton extra, for lots of 2 tons and under 4 tons, 5s. per ton extra, for lots of 1 ton and under 2 tons, 10s. extra, and for lots of 2 cwt. and under 1 ton, 20s. extra.

d Delivered in 5-ton lots at purchaser's nearest railway station. For lots of 2 tons and under 5 tons the price is 5s. per ton extra, for lots of 1 ton and under 2 tons, 10s. per ton extra, and for lots of 4 cwt. and under 1 ton, 20s. extra.

e For lots of 4 tons and under 6 tons the price is 1s. per ton extra, for lots of 2 tons and under 4 tons, 5s. per ton extra, for lots of 1 ton and under 2 tons, 7s. 6d. per ton extra, and for lots of under 1 ton, 20s. extra.

f Prices shown are f.o.r. Widnes.

g Prices shown are ex works London ; f.o.r. southern rails, 1s. 3d. extra.

h Prices shown are f.o.r. Appley Bridge.

i Price shown is f.o.r. Newport, Mon.

h Price shown is f.o.r. Avonmouth.

¶ These are calculated by regarding a ton as comprising 100 "units" (equal parts of 22·4 lb.) so that a fertilizer, for example, with 16 per cent. nitrogen contains 16 such "units" in a ton. Then, if the price per ton of such a fertilizer be divided by the percentage figure, the deduced cost is that of a "unit" of that agent. Those in the table above are based on London prices. (For further explanation, see Advisory Leaflet, No. 146, "The Valuation of Artificial Manures," obtainable from the Ministry free of charge.)

PRICES OF FEEDING STUFFS

Description	Price per ton	Manu- rial value per ton	Cost of food value per ton	Starch equiv. per 100 lb.	Price per unit starch equiv.	Price per lb. starch equiv.	Pro- tein equiv.
	£ s.	£ s.	£ s.		s. d.	d.	%
Wheat, British.. ..	4 18	0 9	4 9	72	1 3	0.67	9.6
Barley, British Feeding	5 8½	0 9	4 19	71	1 5	0.76	6.2
" Canadian No. 3							
Western ..	6 7	0 9	5 18	71	1 8	0.89	6.2
" Australian ..	6 10½	0 9	6 1	71	1 8	0.89	6.2
" Argentine ..	6 7	0 9	5 18	71	1 8	0.89	6.2
" Dutch ..	6 5½	0 9	5 16	71	1 8	0.89	6.2
" Iranian ..	5 5*	0 9	4 16	71	1 4	0.71	6.2
" Russian ..	6 5†	0 9	5 16	71	1 8	0.89	6.2
Oats, English white ..	6 13	0 10	6 3	60	2 1	1.12	7.6
" " black and grey ..	6 10	0 10	6 0	60	2 0	1.07	7.6
" Canadian—							
No. 2 Western	6 18	0 10	6 8	60	2 2	1.16	7.6
No. 1 Feed ..	6 15	0 10	6 5	60	2 1	1.12	7.6
Mixed feed ..	5 17	0 10	5 7	60	1 9	0.94	7.6
Maize, American ..	6 2†	0 7	5 15	78	1 6	0.80	7.6
" Argentine ..	5 17	0 7	5 10	78	1 5	0.76	7.6
" South African—							
No. 2 White Flat	6 3†	0 7	5 16	78	1 6	0.80	7.6
Peas, Russian ..	6 12†	0 16	5 16	69	1 8	0.89	18.1
" Japanese ..	22 5†	0 16	21 9	69	6 3	3.35	18.1
Dari ..	8 0†	0 8	7 12	74	2 1	1.12	7.2
Milling Offals :							
Bran, British ..	4 15	0 17	3 18	43	1 10	0.98	9.9
" Imported ..	5 0	0 17	4 3	43	1 11	1.03	9.9
" Broad ..	5 7	0 17	4 10	43	2 1	1.12	10.0
Middlings—							
fine, imported ..	5 7	0 14	4 13	69	1 4	0.71	12.1
Weatings† ..	5 10	0 15	4 15	56	1 8	0.89	10.7
" Superfine† ..	5 17	0 14	5 3	69	1 6	0.80	12.1
Pollards, imported ..	5 2	0 15	4 7	50	1 9	0.94	11.0
Meal, barley ..	7 7	0 9	6 18	71	1 11	1.03	6.2
" " grade 11	6 15	0 9	6 6	71	1 9	0.94	6.2
" maize ..	6 12	0 7	6 5	78	1 7	0.85	7.6
" "South African	6 0	0 7	5 13	78	1 5	0.76	7.6
" " germ ..	6 5	0 12	5 13	84	1 4	0.71	10.3
" locust bean ..	7 5	0 6	6 19	71	1 11	1.03	3.6
" bean ..	9 7	0 18	8 9	66	2 7	1.38	19.7
" white fish ..	16 2	2 6	13 16	59	4 8	2.50	53.0
" Soya bean							
(extracted)†	9 10	1 12	7 18	64	2 6	1.34	38.3
Maize, cooked, flaked	7 0	0 7	6 13	84	1 7	0.85	9.2
" gluten feed ..	6 10	0 14	5 16	76	1 6	0.80	14.2
Linseed cake—							
English, 12% oil ..	9 15	1 2	8 13	74	2 4	1.25	24.6
" 9% ..	9 2	1 2	8 0	74	2 2	1.16	24.6
" 8% ..	8 17	1 2	7 15	74	2 1	1.12	24.6

PRICES OF FEEDING STUFFS—(continued)

Description	Price per ton	Manu- rial value per ton	Cost of food value per ton	Starch equiv. per 100 lb.	Price per unit starch equiv.	Price per lb. starch equiv.	Pro- tein equiv.
American 5½% Indian 9% Oil ..	£ s. 8 17†	£ s. 1 2	£ s. 7 15	74	s. d. 2 1	d. 1·12	% 24·6
Cottonseed cake, English, Egyptian seed, 4½% oil ..	8 12†	1 2	7 10	74	2 0	1·07	24·6
Cottonseed cake, Egyptian, 4½% oil ..	5 15	0 19	4 16	42	2 3	1·21	17·3
Cottonseed cake, decorticated, 7-8% oil ..	5 7	0 19	4 8	42	2 1	1 12	17·3
Cottonseed meal, decorticated 7-8% oil ..	7 15†	1 10	6 5	68	1 10	0 98	34·7
Coconut cake, 5-6% oil ..	8 5†	1 10	6 15	70	1 11	1·03	36·8
Ground nut cake, 5-6% oil ..	7 5	0 19	6 6	77	1 8	0·89	16·4
Ground nut cake, decorticated, 6-7% oil ..	6 10*	1 0	5 10	57	1 11	1·03	27·3
Ground nut cake, imported decorticated 6-7% oil ..	8 10*	1 10	7 0	73	1 11	1·03	41·3
Palm-kernel cake, 5½% oil ..	7 0	1 10	5 10	73	1 6	0·80	41·3
Palm-kernel cake meal, 5½% oil ..	6 12†	0 13	5 19	73	1 8	0·89	16·9
Palm-kernel meal, 1-2% oil ..	7·0†	0 13	6 7	73	1 9	0·94	16·9
Feeding treacle ..	6 10	0 13	5 17	71	1 8	0·89	16·5
Brewers' grains, dried ale ..	5 0	0 9	4 11	51	1 9	0·94	2·7
" " porter ..	5 0	0 12	4 8	48	1 10	0·98	12·5
" " " ..	4 12	0 12	4 0	48	1 8	0·89	12·5

* At Bristol.

§ At Hull.

† At Liverpool.

‡ In these instances manurial value, starch equivalent and protein equivalent are provisional.

NOTE.—The prices quoted above represent the average prices at which actual wholesale transactions have taken place in London, unless otherwise stated, and refer to the price ex mill or store. The prices were current at the end of May, 1939, and are, as a rule, considerably lower than the prices at local country markets, the difference being due to carriage and dealers' commission. Buyers can, however, easily compare the relative values of the feeding stuffs on offer at their local market by the method of calculation used in these notes. Thus, if linseed cake is offered locally at £11 per ton, then since its manurial value is £1 2s. per ton as shown above, the cost of food value per ton is £9 18s. Dividing this figure by 74, the starch equivalent of linseed cake as given in the table, the cost per unit of starch equivalent is 2s. 8d. Dividing this again by 2·4, the number of pounds of starch equivalent in one unit, the cost per lb. of starch equivalent is 1·43d. Similar calculations will show the relative cost per lb. of starch equivalent of other feeding stuffs on the same local market. From the results of such calculations a buyer can determine which feeding stuff gives him the best value at the prices quoted on his own markets. The figures given in the table under the heading 'manurial value per ton' are calculated on the basis of the following unit prices:—N., 7s. 9d.; P₂O₅, 2s. 6d.; K₂O, 3s. 8d.

FARM VALUES OF FEEDING STUFFS

The prices in respect of the feeding stuffs used as bases of comparison for the purpose of this month's calculations are as follow .—

	<i>Starch equivalent Per cent.</i>	<i>Protein equivalent Per cent.</i>	<i>Per ton £ s.</i>
Barley (imported)	71	6.2	6 3
Maize	78	7.6	5.17
Decorticated ground-nut cake	73	41.3	7 15
„ cotton-seed cake	68	34.7	7 15

(Add 10s. per ton, in each instance, for carriage.)

The Table below is issued as a guide to farmers respecting the feeding value of their crops in relation to current market prices. (The " food values," which it is recommended should be applied by Agricultural Organizers and other advisers in connexion with advisory schemes on the rationing of dairy cows, are given in the December, 1938, issue of the Ministry's JOURNAL, p. 965.)

FARM VALUES

Crop	Starch equivalent Per cent.	Protein equivalent Per cent.	Food value per ton, on farm £ s.
Wheat	72	9.6	6 9
Oats	60	7.6	5 7
Barley	71	6.2	6 3
Potatoes	18	0.8	1 10
Swedes	7	0.7	0 12
Mangolds	7	0.4	0 12
Beans	60	19.7	6 13
Good meadow hay	37	4.6	3 6
Good oat straw	20	0.9	1 14
Good clover hay	38	7.0	3 11
Vetch and oat silage	13	1.6	1 3
Barley straw	23	0.7	1 18
Wheat straw	13	0.1	1 1
Pea straw	23	1.7	2 0

WIRELESS TALKS, JULY, 1939

<i>Station and Date</i>	<i>Time p m</i>	<i>Speaker</i>	<i>Subject</i>
NATIONAL : 6	6 20	Anthony Hurd	Farming Today : The Royal Show and personalities in the Show Yard
MIDLAND : 7 12	9 30 8.15	— —	Hay Harvest. The Strength of the Land
WEST : 13 19	8.00 7 00	Anthony Hurd James Best	How to look at Agricultural Shows.
NORTH : 12	7.10	—	Eye-witness account of the York- shire Agricultural Show

AGRICULTURAL INDEX NUMBER

MONTHLY INDEX NUMBERS OF PRICES OF AGRICULTURAL PRODUCE

(BASE, 1927-29 = 100.)

Uncorrected for
Seasonal Variation

*Corrected for
Seasonal Variation*

Month	1937	1938	1939	1937	1938	1939
January	90	97	90	85	90	84
February	91	95	88	86	89	82
March	90	88	85	90	88	85
April	89	85	85	92	89	89
May	82	82	77	88	90	86
June	81	81		89	90	
July	82	86		88	94	
August	83	81		87	86	
September ..	87	81		89	83	
October	93	86		89	82	
November ..	99	89		92	82	
December ..	100	90		92	82	

THE SAME, TAKING ACCOUNT OF PAYMENTS UNDER THE WHEAT ACT (a),
THE CATTLE SUBSIDY (b), AND GOVERNMENT PAYMENTS FOR MILK (c).

Month	1937	1938	1939	1937	1938	1939
January	92	99	95*	86	93	89*
February	93	97	93*	88	92	88*
March	92	91	90*	92	91	90*
April	90	88	90*	93	92	94*
May	83	84	82*	90	92	91*
June	82	83		89	92	
July	83	88		89	96	
August	85	84*		89	89*	
September ..	89	84*		91	86*	
October	95	91*		91	86*	
November ..	101	94*		94	86	
December ..	102	94*		94	86*	

(a) Commenced August, 1932. (b) Commenced September, 1934.

(c) Commenced April, 1934. * Provisional.

FARM WORKERS' MINIMUM RATES OF WAGES

Agricultural Wages Board.—At meetings held on May 16 and June 20, 1939, Orders were made increasing the minimum weekly rate of wages in Cheshire (from 35s. to 36s.) and continuing unchanged the rates in Buckinghamshire (35s. 6d.), Dorset (34s.), Northamptonshire and Soke of Peterborough (35s.), Oxfordshire (35s.), Staffordshire (35s.), East Riding of Yorkshire (35s. 6d.), North Riding of Yorkshire (35s.), and Anglesey and Caernarvon (ordinary workers 32s. and forestry workers 37s.). (The figures quoted are the minimum weekly wages for ordinary adult male workers unless otherwise stated.) Five further Orders were made fixing special rates of wages for employment on the hay and corn harvests of 1939, the rates for adult male workers being as follows: Cheshire, a differential overtime rate of 10d. per hour; Hertfordshire, a differential overtime rate of 10d. per hour during the hay harvest and of 1s. per hour during the corn harvest; East Riding of Yorkshire, a differential overtime rate during the corn harvest of 1s. 3d. per hour; Anglesey and Caernarvon, a differential overtime rate of 1s. per hour for all workers except those specially engaged for harvest work, in which case minimum rates are fixed at 44s. 6d. per week of 58 hours for

FARM WORKERS' MINIMUM RATES OF WAGES

workers engaged by the week and for those employed on a daily basis, 8s. 8d. per day of 10½ hours on weekdays, except Saturdays when the rate is 5s. per day of 6 hours; Denbigh and Flint, a differential overtime rate of 1s. per hour for workers other than casual workers for whom a minimum rate of 1s. per hour is fixed for all hours worked. Directions were made in regard to holidays with pay, the number of days to be allowed as holidays for whole-time workers in regular employment for not less than 12 months being, in Cheshire, 7 days where the worker is normally employed for 7 days a week, and 6 days in other cases (as formerly); in Anglesey and Caernarvon, 7 days for special class workers, 6 days for other workers except forestry workers, to whom 3 days are to be allowed in respect of 6 months' employment; in Staffordshire, 6 days; in Yorkshire (North Riding), 4 days; in Buckinghamshire and Northamptonshire and Soke of Peterborough, 4 days where the worker is normally employed for 7 days a week, and 3 days in other cases; in Dorset and Oxfordshire, 3 days; and in Yorkshire (East Riding), 2 days. In all instances holiday remuneration is fixed at daily rates proportionate to the minimum weekly rates. For full details of the minimum rates and holiday directions, and of the various provisions connected with them, reference should be made to the Orders, copies of which may be obtained, free of charge, from the Secretary, Ministry of Agriculture and Fisheries, King's Buildings, Smith Square, London, S.W.1.

Enforcement of Minimum Rates of Wages.—During the month ending June 9, 1939, legal proceedings were taken against 5 employers for failure to pay the minimum rates of wages fixed by the Orders of the Agricultural Wages Board. Particulars of the cases follow:—

Committee Area	Court.	Fines Imposed	Costs Allowed	Arrears of Wages Ordered	No. of Workers Involved
		£ s. d.	£ s. d.	£ s. d.	
Bucks ..	Chesham ..	3 0 0	—	65 0 0	2
Lancashire ..	Lytham ..	2 0 0	1 13 0	5 9 10	1
Norfolk ..	Terrington	2 0 0	—	39 11 2	2
	St. Clement				
Shropshire ..	Church	5 0 0	3 18 0	3 18 7	1
	Stretton				
Yorks, E. R.	Beverley ..	4 0 0	0 10 0	114 0 0	4
	Totals ..	16 0 0	6 1 0	227 19 7	10

APPOINTMENTS

County Agricultural Education Staff

Bedfordshire: Mr. R. Kenney, B.Sc., N.D.D., as Agricultural Assistant to the Agricultural and Horticultural Organizer. **Essex:** Mr. T. C. Creyke, N.D.A., N.D.D., as Assistant Lecturer in Agriculture; Mr. A. H. Fitton, B.Sc. (Agric.) N.D.A., N.D.D., as Assistant Instructor in Dairying. **Northamptonshire:** Mr. H. J. Wyles as Senior Instructor in Horticulture; Mr. H. J. Phillips, N.D.H., as Assistant Instructor in Horticulture; Mr. F. J. Sowerby, N.D.A., N.D.D., as Assistant Instructor in Dairy Farming. **Wiltshire:** Mr. J. A. Evans, N.D.D., as Assistant Instructor in Dairying. **Yorkshire:** Mr. D. A. McKenzie, B.Sc. (Agric.), N.D.A., N.D.D., as Lecturer in Agricultural Bacteriology.

RECENT OFFICIAL PUBLICATIONS

The Ministry's Advisory Publications. Since the date of the list published in the April, 1939, issue of this JOURNAL (p. 96), the under-mentioned Advisory Publications have been issued by the Ministry.

BULLETINS :

- No. 4.—Fruit Production: Bush Fruits (4th Edition). 1s. 3d. (1s. 5d. post free).

Describes modern methods of commercial cultivation, with particular regard to the selection of the most suitable varieties.

- No. 5.—Commercial Fruit Tree Spraying: Methods and Costs. (4th Edition.) 1s. 6d. (1s. 8d. post free).

Extensively revised, with special reference to the larger and more powerful spraying outfits now in use.

- No. 13.—Home-Grown Feeding Stuffs (3rd Edition). 1s. (1s. 2d. post free).

Considerably enlarged and re-written. For further information see p. 401.

- No. 51.—Narcissus Pests (2nd Edition). 1s. (1s. 2d. post free).

Contains a new section on the Leaf and Bulb Eelworm, and amplified information on the Bulb Scale Mite and on hot-water treatment.

Copies of the above are obtainable at the prices mentioned from the Sales Offices of H.M. Stationery Office or through any bookseller.

ADVISORY LEAFLETS :

- No. 11.—Winter Moths. (Revised.)

- No. 12.—Mole Draining. (Revised.)

- No. 29.—Notes on Circumstances affecting Quality of Milk. (Revised.)

- No. 121.—Oats. (Revised.)

- No. 122.—Sugar-Beet Growing. (Revised.)

- No. 163.—Onion Fly. (Revised.)

- No. 220.—Barley Growing. (Revised.)

- No. 226.—Red Spider Mite (*b*) Crops in the Open. (Revised.)

- No. 278.—Potato Leaf-Roll. (Revised.)

- No. 297.—Sweet Corn. (New.)

Copies of any of the above-mentioned leaflets may be purchased from H.M. Stationery Office, York House, Kingsway, London, W.C.2, or at the Sales Offices of that Department at Edinburgh, Manchester, Cardiff, and Belfast, price 1d. each net (1½d. post free), or 9d. net per doz. (10d. post free).

Single copies of not more than 20 leaflets may, however, be obtained, free of charge, on application to the Ministry. Further copies beyond this limit must be purchased from H.M. Stationery Office, as above.

A list of the Ministry's publications, including bulletins and leaflets on agriculture and horticulture, may be obtained free and post free on application to the Ministry.

Register of Dairy Cattle. This issue (Volume XXII) of the Register contains particulars of 83 cows in respect of which Certificates of Merit have been awarded by the Ministry of Agriculture since October 1, 1938, as compared with 755 cows entered in the previous volume. To be eligible for a Certificate of Merit, a cow must have given, during a period of three consecutive Milk Recording Years, not less than the prescribed yield of milk, and must normally have calved not less than three times during those years. The prescribed yields for the three-year periods are 30,000 lb. for

RECENT OFFICIAL PUBLICATIONS

Friesians ; 27,000 lb. for Ayrshires, Blue Albions, Lincoln Red Shorthorns. Red Polls and Shorthorns ; 24,000 lb. for all other breeds or types except Dexters ; and 21,000 lb. for Dexters.

The Register contains a statement showing the number and distribution of the yields of the cows of the various breeds entered, and the highest yield certified for each breed for the three years ended October 1, 1938. Of these cows, 12 gave over 50,000 lb. of milk during the three years concerned ; 55 over 40,000 and under 50,000 lb. ; 79 over 35,000 and under 40,000 lb. ; 224 between 30,000 and 35,000 lb. ; 253 between 27,000 and 30,000 lb. ; 149 between 24,000 and 27,000 lb. and 2 between 21,000 and 24,000 lb.

Particulars of pedigree bulls of proved milking strain are also given. The condition of entry of a bull in the Register is that its dam and sire's dam have given the standard yield prescribed for their breed or type in any particular Milk Recording Year. The volume contains entries relating to 11 bulls.

A list of the Milk Recording Societies of England and Wales, with particulars of each Society and the name and address of its Secretary, is included in the Register.

Dairy farmers and others desirous of acquiring high-yielding, milk-recorded cows that have been regular breeders should find the Register a valuable book of reference.

A copy is issued free to all members of Milk Recording Societies (Price 1s., by post 1s. 3d.).

Grain Crops : 1939. A record world crop of wheat in 1938-39, probably a fifth greater than that of the previous year, abundant supplies of barley, oats and rye, and the attendant collapse of grain prices are some of the facts which emerge from a study of this annual review issued by the Imperial Economic Committee. This publication has been considerably enlarged, and in addition to more complete statistics of production and trade than have appeared in previous editions, an attempt has been made to assess the supply position and the consumption of grain in most of the chief consuming countries. The obscurity of the stock position in the majority of countries renders an accurate estimation of consumption impossible, but it is clear that there are ample supplies of grain available for utilization in 1938-39. It also appears that European importing countries, in particular Germany, have been storing part of the available supply as security stock.

In most countries official assistance has been granted to wheat growers, either to maintain their purchasing power, or as a definite step towards self-sufficiency in foodstuffs. The burdensome wheat supplies of 1938-39 have caused an intensification of Government activity, and the review summarizes in an appendix the measures taken in the chief exporting countries. A feature of the 1938-39 grain trade was the appearance of several Governments upon the international market, and this factor, together with recurring European crises, introduced new elements into the trade.

The volume of trade in grain has, according to the report, definitely declined since 1931, exports of wheat for example having fallen from nearly 20 million tons in 1931 to about 13.3 million tons in 1937. A slight improvement occurred in 1938, and shipments in the early months of 1939 have again been heavier. (Price 2s. 6d., by post 2s. 9d.)

NOTICES OF BOOKS

Farming: How to Begin. By A. G. Street. Pp. 179. (London : Faber & Faber. 1935. Price 3s. 6d.)

Mr. Street has given us a book which badly needed to be written.

In the present-day conditions of town employment—the overcrowding—noise and nervous strain attendant on industrial life, it is only natural that many men, middle-aged men even more than those starting life, should turn with longing to the thought of a country life without in the least realizing the difficulties they will have to face in their efforts to make a living as farmers.

The book is a joy to read ; the two chapters on The Farm Pupil could not be bettered, for the rest it is so comprehensive, so direct, so anxious to face the whole issue honestly and yet, to anyone with a real love of the land, there is nothing of discouragement in it, for it breathes such love of the farming life that it rather encourages the true enthusiast than otherwise.

It is good that an expert like Mr. Street should point out, so unequivocally, how useless it is for a man without capital to think of farming as a means of livelihood. Our country-side is littered with the depressing sight of derelict smallholdings and poultry farms, most of them the result of ill-advised ventures of those without capital and with insufficient experience.

Mr. Street stresses in their proper order the primary qualities of the would-be farmer, adaptability, capacity for hard work, handling of men, thrift, and perhaps most essential of all, the readjustment of a townsman's outlook to that of a rural environment.

To a townsman wishing to take up farming as a career, one would do good service by introducing him to Mr. Street's book, and if he were a married man by making a present of it to his wife, for to the man starting on that most hazardous and laborious of all careers—that of a farmer—the loyal co-operation and enduring enthusiasm of his wife is essential.

Literatursammlung aus dem Gesamtgebiet der Agrikulturchemie.

Band IV. "Düngung und Düngemittel." (A Bibliographical List of the Entire Domain of Agricultural Chemistry. Vol. IV, Manuring and Fertilizers). By H. Niklas, F. Ader, F. Czibulka, F. Kissel, F. Kohl. Pp. xxxix + 1144. (Leipzig : Helingsche Verlagsanstalt. 1938. Price RM. 45.)

This is the fourth volume in the fine series of reference bibliographies produced under the direction of Dr. Niklas of Munich. The earlier volumes have dealt with soil science, soil analysis and with plant nutrition, while the volume under review is concerned with manuring and fertilizers. The book brings together in a very convenient form, citations of articles on all questions relating to fertilizers and manuring which have appeared over the last twenty or thirty years, in scientific journals of repute in German, French and English. To the scientific worker this book will be invaluable. It is clearly printed and well arranged, and is provided with sub-titles in English. The reception which will be given to this work should not be less cordial than was accorded to its predecessors in this series.

The Changing Village. By F. G. Thomas. Pp. 188. Discussion Books No. 25. (London : Thomas Nelson. 1939. Price 2s.)

English rural life has received harsh treatment from the pens of the writers of the post-war years. On the one hand, novelists of the Powys school have presented a picture in which the village was little better than a plague spot, brutish and unmoral. On the other hand, the possibly more dangerous writers who were inspired to "do right by the village,"

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have idealized and sentimentalized it until, to a villager or true countryman, it was unrecognizable.

It is refreshing to find a book on this subject that suffers from neither of these faults. Mr. Thomas has no illusions regarding rural decadence, but it is not a decadence of character he finds. He is an enthusiast for the regeneration of the village and rural England, but he is not prejudiced. His main plea is for the treatment of the rural problem on a regional basis, and throughout, his argument is challenging. The whole book is leavened with common-sense tinged with just sufficient bias to engage the reader's debating instincts. As a "Discussion Book" it fits in admirably with the more intelligent townsman's recent real interest in rural social problems. As a piece of publishing and a source of information it is remarkably good value.

Survey of the Trade in Canned Food. Pp. 170. Report No. 32 of the Imperial Economic Committee. (London: H.M.S.O. 1939. Price 2s 6d.)

This Survey reviews the international trade in each of the five main groups of canned food over the period 1932-37, with special reference to Empire supplies and the United Kingdom market. In the main the picture is one of expansion and progress, but the Committee have added a warning against the assumption that canning is an easy means of dealing with surplus produce or bumper crops. The canner needs a supply that is regular in volume and uniform in quality. For growers this means specialized activity and in varying degrees a specialized product, e.g., the cultivation of definite "canning" varieties of fruit and vegetables is now common. The standard of selection at the cannery is rigorous, all the more so in times of glut. Canning is still speculative. A heavy pack may mean a heavy carry-over of stock, and weak prices. The canning season is short, thus complicating labour supply. Overheads may be reduced by canning a variety of products, but the scope is limited. Thus the uneven bounty of nature may be as serious a problem for growers and packers in the canning industry as in any other branch of agricultural production and trade.

Principles of Feeding Farm Animals. By Bull and Carroll. Pp. xi + 395. Illus. (New York and London: Macmillan & Co. 1937. Price 15s.)

In writing this book the authors had principally in mind the needs of students at the agricultural colleges in the States, but they express the hope that it will also prove of value to the practising farmer. The book presents a very clear and readable statement of accepted doctrine with regard to animal nutrition; it is commendably simple in style and devoid of unnecessary technicalities, so that the working farmer need not be deterred from its perusal by reason of imagined difficulties. References in the text are to American conditions, but apart from this the book should prove of value to students and farmers here as well as in America. The volume is admirably produced.

Management of Dairy Plants. By M. Mortensen. Revised. Pp. ix + 407. Illus. (New York and London: Macmillan & Co. 1938. Price 13s.)

This American manual deals with the establishment, maintenance and development of Creameries in the U.S.A. Butter, Ice Cream and Cheese are the products envisaged, and the subject is treated mainly from the commercial point of view. Technical processes are not described in detail. The book is designed to instruct Directors and Managers of such

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Creameries in the financial aspects of their tasks, and it is packed with business information covering a wide range.

In the preliminary survey the author points out that, "A new Creamery should never be started merely because a neighbouring Creamery is a financial success No new enterprises should be started except for the purpose of making it possible for the producers to obtain a greater return from their milk and cream." Again, Chapter 21 opens with the dictum, "It should ever be remembered that the Dairy manufacturing plant stands as the Marketing Organisation of the Milk Producers, and the Manager of that organisation should endeavour to have the milk converted into such products as will assure the greatest return to the producers."

Considerable space is given to such matters as the "Over-run" in butter and in ice-cream making, whereas Cheese-making is dismissed in a page. The general scope, however, is comprehensive, and the topics range from Sewage Disposal to Advertising, and from Debt Collection to Trading in Futures. A timely warning is given against excessive record keeping when preparing costings data, for it is pointed out that it is possible to devote so much time thereto, that it represents a net loss to the organization, instead of a gain.

The material throughout is presented in a clear, readable style; and the book will be useful to dairy staffs both as a work of reference, and as a compendium of business methods as applied to milk factories in general, wherever they may be located.

Field Manual in Toxicology for Agricultural Workers. By Clinton H. Thienes. Pp. vi + 39. (Michigan, Ann Arbor: Edwards Bros. 1938. Price \$1.)

This concise pamphlet deals with a subject of rising importance in view of the extended use of poisonous materials in agriculture and horticulture. Caustic, metallic, non-metallic and organic poisons are described, their use indicated, and directions given for diagnosis and first-aid treatment.

Particular interest attaches to its format, as the pamphlet has been produced by photo-lithography from a perfect typescript, in an attempt to reduce costs on a technical work for which only a comparatively small demand may be expected. The reproduction is good, but by British standards the price is high.

Le Soja et les Industries du Soja (Soya-bean and Soya-bean Products) By A. Matagrin. Pp. x + 390. Illus. (Paris: Gauthier-Villars. 1939. Price 60 frs.)

This comprehensive survey of the agricultural, industrial and commercial history of the soya-bean, its botany, its chemistry and its cultivation, and the uses of the many products derived from it, is admirable in its thoroughness of treatment. While methods of cultivation—Oriental, American and European—are fully described, even to the selection of seed and the control of pests and diseases, the emphasis of the work is industrial, the major part dealing with the preparation of soya milk, soya flour and soya oil, followed by descriptions of the use of the bean in the modern manufacture of vegetable lecithin, vegetable casein, plastics, paints, artificial silks, fertilizers, synthetic rubber and resins.

Report of the National Institute of Agricultural Botany, 1937-38. Pp. 26. (Copies may be obtained free on application to the Institute, Huntingdon Road, Cambridge.)

Much of this Institute's work concerns the trial of new varieties of crop plants, and the farmer who takes advantage of the frequent reports issued by the Institute can save himself a considerable amount of time, trouble

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and expense in trying things out for himself. The scope of the work undertaken is well illustrated by the sketch map which is included in the report.

Many of the notes supplied in the present report relate to types which are still only in the early stages of trial, but are none the less interesting because of that fact. At a time when high production per acre is a question of more than usual importance, the Institute's tests of the ability of certain varieties of wheat to respond to high levels of manuring without lodging will be followed with particular interest.

The report indicates that seed of a carefully purified stock of Spratt-Archer barley and of a selected high-yielding strain of Rivet wheat will be placed on the market by the Institute at the end of the present season.

Modern Cereal Chemistry. By D. W. Kent-Jones. 1'p. vii + 720. (Liverpool : Northern Publishing Co. 1939. Price 30s.)

That this work, first published in 1924, should have required a third edition, is an indication both of the demand for a comprehensive work on cereal chemistry, and of the excellence of Dr. Kent-Jones' volume. The book opens with an interesting description of the principal world wheats, and then proceeds to discuss the technicalities of the treatment of cereals for bread making, in chapters on flour strength, the technique and chemistry of the baking process, bleaching and flour improvers, nutritive value of bread, etc. The value of Dr. Kent-Jones' book lies principally in its careful marshalling of authorities and in its lucid exposition. As a work of reference the book deserves and will doubtless receive high praise.

A Classified List of Tulip Names. Pp. 119. (London : Royal Horticultural Society. 1939. Price 2s. paper, 3s. cloth.)

This list, containing over 4,300 names, of which about 500 are synonyms, should effectively remove the confusion which, during the past 20 years, has accumulated through the careless naming of many hundreds of new tulips. The classification of each variety, according to the revised system, is given, together with a brief colour description and, when known, the name of the raiser. The publication will be invaluable to professional and amateur growers and to bulb merchants.

The Book of the Mushroom. By A. Defries. Preface by J. Ramsbottom, O.B.E., M.A. Pp. xiv + 130, and 24 Figs. (London : Methuen and Co., Ltd. Not dated. Price 2s. 6d.)

This is a cheap reissue in paper wrappers of "The Book of the Mushroom," noticed in this JOURNAL for July, 1936. The work gives a clear account of mushroom production in specially prepared beds and by the use of pure culture spawn. Disease and pest control are dealt with, and advice is given on picking, packing, marketing and cooking.

Pigs : Their Breeding, Feeding and Management. By V. C. Fishwick. Pp. 170. Illus. (London : Crosby Lockwood. 1939. Price 7s. 6d.)

For the past seventeen years Mr. Fishwick has investigated the different systems of pig-keeping at the Pig Husbandry Research Station at Wye College, and in this book describes the methods of management that have been tested and found to be efficient from the economic standpoint.

The author discusses in detail the method of selection, management and feeding of the breeding herd ; the problems which arise in rearing and how to ensure healthy litters ; together with the methods of management for the production of both pork and bacon. Under " policy," herd

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organization is outlined, giving programmes worked out to meet contract sales for pork and bacon.

The relative merits of indoor and outdoor management for the various classes are considered, and the types of housing suitable under each system are described, with working instructions, in the appendix, for the erection by farm labour of sties with yards, the field hut and the open hovel. A chapter on health and disease and a summary of rations complete an essentially practical treatise which can be recommended to the pig-keeper and to the student.

Changes in the Economic Organization of Agriculture. A comparative Study of Conditions in the Eastern Counties of England in 1937 and 1938. Report No. 27 of the Farm Economics Branch, University of Cambridge Department of Agriculture. Pp. 48. (Cambridge : Department of Agriculture. 1939. Price 1s. 6d.)

This report is the fourth of a series of which the main object is to examine the changes occurring from year to year in the financial and quantitative aspects of farm organization in the Eastern Counties.

The year 1938, which is here compared with 1937, was the most unprofitable one recorded in these surveys since 1932. Net returns averaged some 12s. per acre less than in 1937, and nearly 20s. per acre less than in 1936. The complex factors of this deterioration are examined in detail.

Weeds : Weeds : Weeds. By Sir C. V. Boys. Pp. 113. 2nd edition. (London : Wightman & Co. 1938. Price 2s.)

In his preface to the first edition of this work, dated 1937, the author expressed the hope that his readers would supplement his experience. They have done so, and he is enabled to "change over from the monologue . . . to a general conversation." Happily, the change has not destroyed the intimate, if somewhat unconventional, style of this lively account of modern weed warfare.

National Farmers' Union Year Book, 1939. Edited by Cleveland Fyfe. Pp. 508. (London : National Farmers' Union. Price 5s.)

This now familiar annual provides ample evidence of the wide variety of the activities of the National Farmers' Union, and gives in concise form a large amount of information of concern to farmers. Of particular interest are the statistical sections, the statement of policy as enunciated last October, the chapter dealing with agricultural legislation during the past year, and the section by Mr. C. H. Tolley on Farmer's Income Tax.

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Evening Milking Time

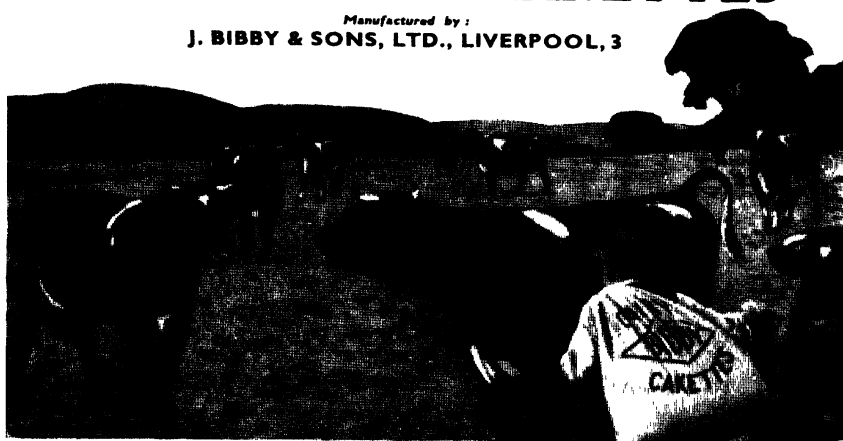
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THE JOURNAL OF THE MINISTRY OF AGRICULTURE

VOL. XLVI

No. 5

AUGUST 1939

Future of the Attested Herds Scheme.

The following statement on the subject of the future of the Attested Herds Scheme was made by the Minister of Agriculture and Fisheries in his speech in the House of Commons on the Second Reading of the Milk Industry (No. 2) Bill* on July 7, 1939:—

“ One other aspect of long-term policy to which I should like to refer is the Attested Herds Scheme. The Bill makes the same provision for Exchequer contributions towards quality premiums in respect of milk from attested herds during the two years ending September 30, 1940, as was made in the former Milk Industry Bill, and the question whether any such provision should be made after that date will be considered in connexion with long-term legislation for the milk industry. But apart from these quality premiums, owners of attested herds receive a bonus in respect of disease eradication under Section 20 (1) of the Agriculture Act, 1937, the operation of which extends at present to January 31, 1941. I have recently had under review the future of this scheme and I have come to the conclusion that the payments made under the scheme in respect of disease eradication should be considered, as far as possible, independently of the various considerations affecting milk policy generally.

It will be recalled that the former Milk Industry Bill contained a Clause extending the period of operation of this Subsection to the end of September, 1943, that is to say, to the end of the period covered by the quality milk provisions of that Bill. It would be inappropriate in a purely interim Measure to include a long-term provision of that type, but it is desirable that some indication should be given at this

* See note on p. 510.

stage as to the future of the Attested Herds Scheme as a means of eradicating disease.

It is the Government's intention to introduce legislation at the first suitable opportunity to provide for the extension of the period of operation of the Subsection up to September 30, 1948. In so far, however, as the payments made solely in respect of disease eradication are made by way of compensation for the additional expenditure incurred in ridding a herd of tuberculosis and qualifying it for attestation, I do not think they should be of an indefinite duration. This principle is already applied in the case of the alternative capitation bonus under the Attested Herds Scheme, which is payable for a period of three years. It is proposed that after January 31, 1941, milk bonus payments under this scheme will likewise be received only by an individual owner for a period of three years in all, including any period prior to that date in respect of which bonus has been paid. It is also proposed that the rate of this milk bonus up to September 30, 1943, shall be the same as at present, namely, 1d. per gallon, or its equivalent in capitation bonus if we decide to pay on that basis. I am not in a position at present to indicate what the rate of bonus will be in the period subsequent to that given, but that matter will be reviewed during the preceding period in the light of the progress made by the scheme and other considerations, and as long notice as possible of any proposed change will be given.

The Clause in the former Milk Industry Bill which extended the period of operation of Subsection (1) of Section 20 of the Agriculture Act, 1937, also provided for the repeal of Subsection (2) of that Section, which enables Orders to be made compelling Milk Marketing Boards after the end of January, 1941, to make payments, not exceeding 1d. per gallon, to registered producers with attested herds. The question of this contingent liability of Milk Marketing Boards for payments in respect of disease eradication will be considered in connexion with the proposed legislation extending the period of operation of Subsection (1) of Section 20 of the Agriculture Act, 1937."

FRUIT JUICES AND SYRUPS : A NEW BRITISH INDUSTRY*

VERNON L. S. CHARLEY,

*Fruit Products Section, University of Bristol Research Station,
Long Ashton*

" He had been eight years upon a project for extracting sunbeams out of cucumbers, which were to be put into phials hermetically sealed, and let out to warm the air in raw, inclement weather." So wrote Dean Swift in *Gulliver's Travels to Laputa*, and although these researches of the Laputian were of obvious importance we are not told what success attended his efforts. But much more importance attaches to the results which have attended the work which has been in progress for the past eight years at Long Ashton and which has been concerned not with extracting sunshine from cucumbers but with extracting attractive, health-giving, pure juices from our English fruits. The description of the original research work and its application to commercial projects will be presented chronologically in this article as a straightforward story of the utility of an investigation financed by the Ministry of Agriculture and Fisheries for the direct benefit of the British fruit grower.

The Problems. A further quotation from Swift's travel satire is as follows: " And he gave it as his opinion that whoever could make two ears of corn, or two blades of grass, to grow upon a spot of ground where only one grew before, would deserve better of mankind and do more essential service to his country, than the whole race of politicians put together." The 20th century has seen this process being put into effect for corn and grass, and horticulturists are well aware of the efforts both on their own part and by research workers whereby two apples or two berries or two currants have grown

* Readers who may wish to read a detailed and comprehensive account of the manufacture of fruit juice are recommended to obtain *Technical Communication No. 11 of the Imperial Bureau of Horticulture and Plantation Crops*, published by the Bureau at East Malling, Kent. Price 5s. This, the first complete account of the various methods of manufacture, not only deals with every stage from the selection of the fruit to the disposal of the final product, but surveys the economic and nutritional aspects of the industry.

FRUIT JUICES AND SYRUPS

where only one grew before. Apart altogether from mere increases in acreage, the trees and bushes have themselves been forced into richer fruitfulness; and this process, multiplied on all sides with all fruits and in all countries, has had the unfortunate effect of causing over-production and, in some seasons, a tragic waste of good fruit because of the inability of the marketing and economic systems to absorb it. Many appalling stories of waste are recounted, but two instances known to the writer can be vouched for and suffice to indicate the urgency of the problem. In 1936, a large bulk of several tons of red gooseberries of splendid quality was seen being unloaded by the banks of a small river which at high tide would remove the "useless refuse" into the North Sea! Again, two years ago, in Worcestershire, one farmer alone rolled in twenty tons of perfectly sound apples of cooking sorts. Such instances, multiplied many times over, are indicative of the need for some useful outlet for such bulks of fruit. Again, the grading schemes of the Ministry would have been even more acceptable if means had been available for the economic utilization of those quantities of fruit which were discarded for inclusion in the main grades of market fruit, discarded often merely on account of size, shape or surface insect damage.

The problem was rendered more difficult by reason of the unstable nature of the type of fruit which it was desired to utilize. Windfall apples could not be stored for any length of time, and soft fruits, especially in inclement weather or over week-end periods, deteriorated at an alarmingly quick rate. Stated in the simplest terms, the problem was to discover ways in which these bulks of unstable fruits could be processed into stable beverage products, capable of long-term storage. Could we extend the season for strawberries from June until Christmas, and even round to the following June, by means of juices and syrups prepared from fruit which would rot on the ground unless some such processing were carried out on it?

Preliminary Tests. In 1932, the writer was appointed to investigate the general problems of utilization of fruit for beverage production. A survey of the beverage industry suggested that whilst many so-called fruit drinks, innocent of fruit content, were on the market, their flavours were reminiscent of no fruits known to fruit growers. Attention



FIG. 1 - Five hundred gallons of strawberry syrup being mixed at the Bristol factory

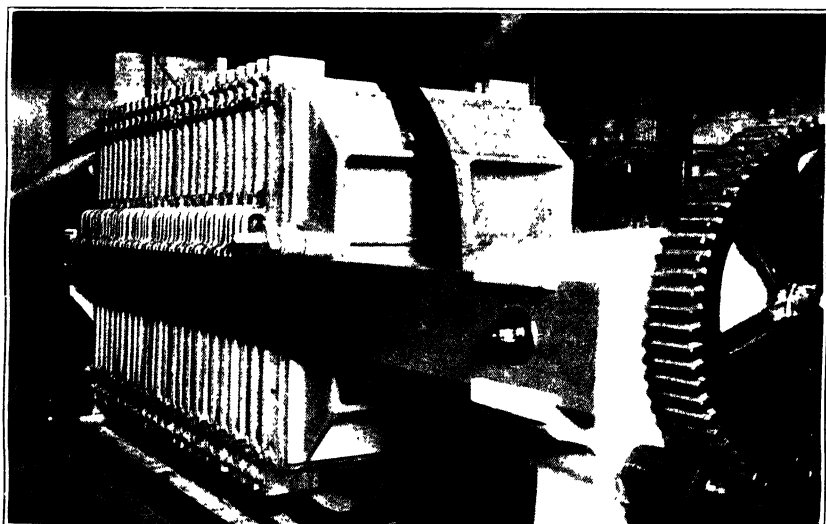


FIG. 2 - Filter for fruit syrups at Bristol factory

To face p. 120.

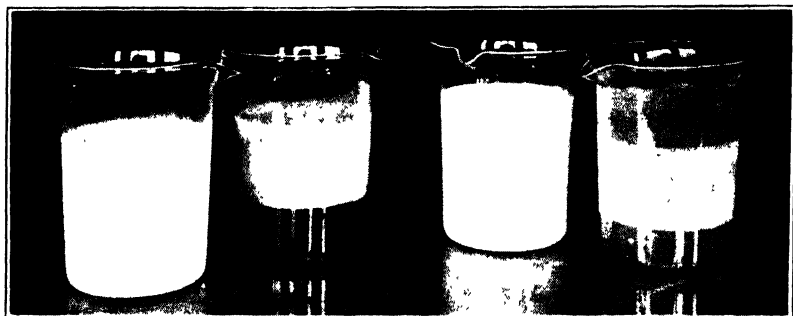


FIG. 3 — Hot milk shakes 12 hours after mixing. Note absence of curdling in the two treated samples. [Copyright Long Ashton Research Station]

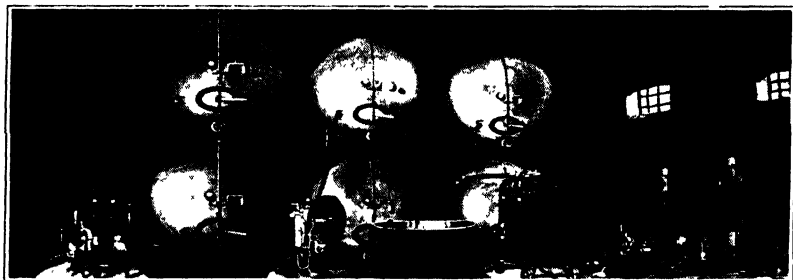


FIG. 4 — Battery of 5,000 gallon pressure tanks for storage of apple juice. [Copyright J. C. Carlson]



FIG. 5 — Experimental sterile bottling room at Long Ashton for cold processing of apple juice. [Copyright Long Ashton Research Station]

FRUIT JUICES AND SYRUPS

was consequently paid to the question of obtaining a series of liquid-fruit products which would retain the true, fresh fruit character to the fullest extent. The research workers were not hindered by the reiterated statements of some manufacturers that pure fruit products were not technically capable of being made on account of their liability to ferment, and the early work showed that, with proper and careful attention to detail, very attractive, and yet stable products could be made from fruits of all kinds. The even tenor of this phase of the investigations was interrupted by the implications of the commencement of the phenomenal rise to popularity of the Milk Bars. The remarkable food value of a milk shake prepared by the incorporation of a pure fruit syrup in a supply of safe milk was early recognized, and some of the writer's very first experimental syrups—laboriously prepared in a homely manner by stirring in the sugar by hand on broiling summer days—were tried by the National Milk Publicity Council's staff and pronounced to be good. And so the Milk Bar at the Imperial Fruit Show at Cardiff in 1935 made extensive use of the new pure fruit syrups, and the complete stock at Long Ashton was insufficient to meet the demand.

The First Factory. So far the research work had shown the possibility of producing attractive, marketable syrups from strawberries, loganberries, raspberries and black currants, and appeared, at that time, to have reached the useful limit of work along this line. But the discrepancies between laboratory experiments and commercial production were soon to become painfully apparent. The success of the Long Ashton syrups at the Cardiff Milk Bar had created a demand, and a Bristol firm, convinced of the possibilities of such a range of products, arranged with the University of Bristol that the writer should be available to equip and take control for two seasons of the first fruit-juice factory in this country. Zero hour was 6 A.M. on June 10, 1936. Into a fine factory in Bristol, equipped with the very latest type of plant, four tons of strawberries from Wisbech arrived to be followed daily by similar loads. From that moment problems arose in confusing multiplicity: day after day consignments of fruit arrived, often in such a condition owing to a series of heavy thunderstorms, that instant processing was necessary. Pressing out 28 lb. portions of berries proved to be a vastly different proposition from dealing with 4 tons a day, and this

FRUIT JUICES AND SYRUPS

one problem alone was only solved after a considerable amount of biochemical work had been carried out. The difficulty was to erect a stable "cheese" after the manner of cider-making. Owing to the soft consistency of the strawberries, the cloths and racks slipped in all directions, and often six men were required to maintain any semblance of vertical form as the enormous pressure was applied to express the juice. Eventually, a process was discovered which completely transformed this phase of the operations. A material was added to the milled strawberries which, after 12-16 hours, caused the juice to separate and the tissues to rise to the top of the large vats. Hundreds of gallons of brilliant, red juice could be run from the vats, leaving a hard residue of solid fruit material which was capable of being pressed with the greatest ease and efficiency. Later, it was found that this process also increased the yield of juice, improved the colour and gave a juice with a fuller flavour than had previously been obtained. Other problems of similar urgency were overcome with more or less difficulty, and after 14 days of practically continuous work, a contented team of workmen, members of the firm's administrative staff, and the writer, who had all worked for a straightforward 56 hours with only odd hours for rest, ended this phase of production at 5 A.M. one morning with a welcome respite and sleep. Research had proved its worth. A commercial process had been evolved which functioned smoothly, was capable of expansion to suit the inflow of fruit and which proved to be comparatively inexpensive for labour.

Black currants contributed their quota of difficulties but the special material used for strawberries again proved its worth by minimizing the difficulties of juice expression.

On July 29, 1936, however, the first signs of trouble were seen—and heard—when a batch of 12,000 gal. of strawberry syrups stored in glass gallon jars commenced to blow their corks with deafening reports. Examination showed the presence of millions of live yeast cells which were causing an active fermentation in the syrup. The syrup was refiltered but with little effect. A further filtration 2 weeks later was no more successful in preventing the developing of the yeast cells and some other method for their suppression had to be found. Eventually the clue to the mystery was given by a comparison of the chemical composition of the black-currant syrup, which was quite sound, and of the strawberry syrup

FRUIT JUICES AND SYRUPS

—which was not. The very much higher acidity of the former product suggested that the yeasts may not be able to develop in such a sharp liquor and in consequence the strawberry syrup was acidified to a degree only slightly below that of the currant syrup. Complete stability immediately resulted and a further difficulty had been overcome. Strawberry syrups retained for observation from these batches are perfectly sound to-day.

One further allusion to the growth of fruit product problems on the snowball principle can be cited here. Practically all the syrups made at this period were sold to Milk Bars for the making of milk shakes. Whilst the acidified syrups proved to be quite satisfactory for cold milk shakes (i.e., caused no curdling) it was entirely otherwise with hot milk drinks when the autumn months brought a demand for them. Such syrups when mixed with almost boiling milk quickly caused a slight separation of curds and whey and a trail of only half-emptied glasses at some of London's most popular Milk Bars suggested forcibly that some solution must be found quickly. Many weeks elapsed before a suitable method of treatment was worked out, but now it is possible to mix all the syrups with boiling milk without curdling the casein.

Fruit Syrup Process. The actual sequence of processes for fruit syrups will be briefly described. The berries or currants are milled very finely and received into large tanks for the enzyme treatment. Chemical tests indicate when fermentation is liable to cause trouble or, alternatively, when the enzyme has completed its task. Often the chemist in charge is presented with a difficult choice when fruit is coming into the factory in abnormally large quantities, for fermentation may ensue before the enzyme has finished its work. Instant decisions are called for, because one of the prime factors in obtaining clean, fresh fruit flavours is the prevention of excessive fermentation, and a way has been found to prevent fermentation but to allow the enzyme to continue at work. The juice is expressed in hydraulic presses exerting up to 200 tons pressure and mixed with solid cane sugar in large mixing tanks that can dissolve $2\frac{1}{2}$ tons of sugar into 400 gal. of juice in three minutes without the use of heat. The resultant syrup is acidified where necessary, treated with a permitted preservative and filtered to a brilliant condition through large filters with outputs of 300 gal. an hour.

FRUIT JUICES AND SYRUPS

Uses for Fruit Syrups. Many recipes have been worked out for the domestic use of fruit syrups and are given in the National Mark Fruit Syrup leaflet. As bases for jellies made entirely in the cold, cake fillings and icings, ice-cream pour-overs and flavourings and for home-made milk shakes these syrups have many attractions. Children who are squeamish over pure milk often take a fruit-flavoured milk with relish, and it is suggested here that it would provide a profitable and reasonable liaison between agricultural and horticultural interests for an attempt to be made to determine whether the Milk-in-Schools Scheme could not be brought back into its former flourishing state by the provision of fruit-flavoured milk shakes. A series of syrups of intriguing flavours is now readily available and their variety should provide an attraction to the children.

Black-Currant Syrup and Physical Disorders. In November, 1938, the first indications were received at Long Ashton that National Mark black-currant syrup probably possessed curative properties of a remarkable nature. It appears that a large number of people have found this syrup to be of great value in duodenal or stomach ulcer complaints and some amazing cases of recovery are known. In many cases properly attested medical evidence is available that patients have been unable to take other forms of fruit, either in liquid or solid form. This constitutes a most important discovery, for black currants are this country's most important source of vitamin C and the value of the syrup as a medicine may be due to this vitamin. From a wider aspect, it is obvious that a large supply of black-currant syrup would be of national importance in the event of any circumstances arising that would prevent the importation of citrus juices, which are now the chief source of natural vitamin C from fruit.

Apple Juice. During 1936-37, in both of which years Long Ashton took responsibility for the syrup production at the Bristol factory, there was also the commencement of an analogous industry concerned with apple juice. The writer had organized three tours of studies for cider-makers to various Continental countries and the amazing strides made by the apple-juice industry in Germany and Switzerland were most significant. It was indeed a strange sight to see the

FRUIT JUICES AND SYRUPS

homely, beer-drinking, wine-loving Germans quaffing large quantities of chilled, unfermented apple juice. In fact, in 1937, the Germans produced and consumed 15 million gal. (from 150,000 tons of fruit) and the Swiss 6 million gal. In this country the Ministry's marketing staff considered it inevitable that apple surpluses on a large scale would ultimately arise. Since 1933, methods of producing apple juice had been studied at Long Ashton with a view to utilizing such surpluses. German methods were used at first and were merely applied to home-grown fruit, but later, in 1937-38, it became necessary to develop independent methods to suit the particular difficulties of the home fruit supplies.

THAT "COX" FLAVOUR! One of the most interesting problems that was studied was an attempt to produce a range of apple juices which would retain the true characteristic flavour of the raw fruit. The research workers visualized a range of juices made from Cox's Orange Pippin, Laxton's Superb, Worcester Pearmain, Bramley's Seedling, etc., but the juices that were made from these fruits did not resemble the single varieties except for sweetness and acidity. Indeed, if the juice of Bramley's Seedling apples was chemically adjusted to the same sugar and acid content as that of Newton Wonder, Wellington, Lord Derby or even Cox itself, then the series of juices obtained were practically identical in fruit flavour. The Cinderella amongst well-known varieties was Worcester Pearmain, for the hard "woody" character was not modified by any treatment that was tried. It still remains for research to act as a fairy godmother to the Worcester variety and transform its juice into a palatable beverage.

In attempting to impart the special flavours of each apple to the expressed juices, the milled apples were macerated (i.e., left in the milled condition for various periods) in order to try and dissolve out the flavour character. This particular method did not prove to be useful, but an adaptation of it, in which the juice was immediately expressed and a certain proportion of the press-cake disintegrated and returned in a porous bag to the juice, did have a very important effect on flavour, making all the difference in some of the cooking-apple juices. These results of the Long Ashton maceration method have already proved to be useful not only in England, where Kent and Sussex apples have been similarly processed, but also in New Zealand where very attractive juices have been made by means of a similar maceration.

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COLD VERSUS HOT PROCESSES. The German tours showed that two main processes were in use. The cold process involved passing the juice through a special filter which literally "sieved" out even the most minute of the yeasts and thus prevented fermentation. The hot process achieved freedom from fermentation by killing the yeasts in the juice by the application of heat. The flavours of the English products varied according to the process. The cold method gave a clean, fresh juice with the true fruit character of a juice tasted straight from the press, but the flavour was usually not intense, especially with English-grown cooking apples. The hot-processed juices lost a very slight proportion of their freshness, but the total flavour was more intense and the juices were full-bodied and mellow. Here was a dilemma! The cold and hot juices presented both desirable features and negative characters simultaneously, and finally it was left for individual manufacturers to decide which particular character to develop. Attempts to discover which type of juice was preferred by the general public culminated in five juices being tasted at the Annual Tasting Day at Long Ashton on May 4, 1939, when 238 visitors tasted and reported on the juices and voted very heavily in favour of the hot-processed juices. Their motto was evidently "value for money," for the cold-processed juice was a fresh, clean and attractive drink, but not so fully flavoured as those which had been heated.

In this connexion mention should be made of an interesting series of investigations concerning the stabilizing of apple juices by heat. It was found that if juices were processed in the presence of carbon dioxide the "cooked taste" was not so noticeable. This effect was ultimately tracked down as due to the presence of oxygen or air in the juices causing an "oxidation" of the flavouring compounds. In consequence of this, another process (deaeration) was inserted in the main sequence, whereby practically all the air and oxygen dissolved in the juice were removed and the juice could then be pasteurized without acquiring the "apple pie" character.

COMMERCIAL DEVELOPMENT. As a direct result of the Long Ashton cider-making tour to Germany in 1935, an apple-juice factory was established at Totnes in Devon in 1936. Three 5,000-gal. pressure tanks were installed to hold the juice free from fermentation during its storage. A modified cold process was used with cider-apple juice, and eventually a stable, high-class beverage was prepared and is now in commercial dis-

FRUIT JUICES AND SYRUPS

tribution. The following year saw the installation of six large pressure tanks for the storage of apple juice at a new factory in Wisbech. The Wisbech firm, however, has naturally wished to make extensive use of cooking and dessert fruit and has only utilized cider fruit when it became uneconomic to purchase market varieties. Cider fruit is most valuable in giving a rich, full flavour to the juice, and growers would be well advised to consider headworking a definite proportion of their unprofitable trees with bittersweet cider varieties, for an addition of even 10 per cent. cider fruit will greatly improve the character of a cooking-apple juice.

At the same time as the Wisbech venture, a combine of growers in Sussex commenced to process their surplus fruit into juice. Amazingly rich beverages were made here, and even Worcester juice became more palatable. Experience such as this shows that flavour is ultimately connected with soil, manurial and cultural conditions, and there is yet a great deal to learn before the quality of blends can be foretold or reproduced with any accuracy.

In 1938, apple juice was made from Kent apples for the first time both at a factory in Kent and at the Sussex plant. This year also saw the commencement of a complete hot-process production in Worcestershire, where cider apples predominated in the blend. A really luscious product, redolent of the full character of freshly-pressed juice was obtained and should find favour with the public, but in view of the general shortage of cider fruit (it is all needed for the cider industry) such products as this cannot be regarded as being available for distribution on a national scale.

APPLE-JUICE CONSUMPTION. In 1936, the consumption of pure apple juice in this country was probably about 15,000 gal. The consumption now is nearer to 40,000 gal., and this amount is likely to be trebled in the autumn of 1939. There is a likelihood of a heavy crop this season, and although the existing industry cannot be expected to make much of an impression on the surplus apple position should a real glut of apples arise, a definite start has been made and there would seem to be no reason why the industry should not expand to many times its present size in a comparatively short time. The liquid products of English fruits are luscious, healthy, attractive beverages. They represent a new type of drink; they have the beneficial effect of medicines without possessing their "medicinal" tastes, and, suitably protected against

FRUIT JUICES AND SYRUPS

unscrupulous competition from spurious products masquerading under the guise of pretty labels and descriptions of most deceiving nature, there should be a very considerable future for the English fruit juice and syrup industry. Such an industry would provide a valuable additional outlet for fruit, would do something towards easing the problems of distribution and, finally, would subscribe in some way to the improvement of national health.

Very interesting data are continually being received concerning the health-giving value of apple juice, especially for babies and children who are anaemic or suffering from various complaints. Ultimately it must be left to the medical profession to determine the precise usefulness of these juices, but evidence in Germany and Switzerland in conjunction with the rapidly-growing list of people who have found benefit from such products suggests that pure fruit juices combine the most attractive features of flavour with health-giving qualities of no mean order.

The Future. The research work at Long Ashton is now concerned with various longer term investigations. Should a heavy glut occur, can the juices or syrups be stored over several years without detriment? Or is the problem of long-term storage quite uneconomic? Can concentrated fruit juices be considered as the salvation of the industry during glut conditions, and, if so, what process can be most satisfactorily used?

All these problems must be considered if the fruit-juice industry is to be of maximum utility to the fruit grower. Their solution and others is essential if the industry is to develop in a rational and stable manner and achieve ultimate success.

ACCREDITED MILK

W. T. PRICE AND R. J. FLEMING

Agricultural Education Department, Wilts C.C.

The Accredited Milk Scheme, first introduced in Wiltshire, and on a county basis in 1929 as a "register" of Accredited Producers, has made considerable progress during the past ten years and done much to increase the hygienic quality of the milk supply of England and Wales.

There is, however, a need for expansion of the Scheme, with the ultimate object that all milk used for human consumption will at least be up to Accredited standard. In most counties there are many dairy farmers still outside the Scheme. For example, the milch cow population of Wiltshire at June, 1939, was approximately 97,500, and the number of registered milk producers approximately 3,450. Of these, 36,780 cows (5,170 T.T. and 31,610 Accredited) or almost 38 per cent. of the cow population, were in herds licensed to produce designated milk. The total number of licences in force (953), however, represents only 26 per cent. of the registered milk producers in the County. This appears to indicate that many of the smaller producers are not taking advantage of the benefits to be derived from the Scheme, and this has in fact been found to be so.

It is not easy to explain why such a large proportion of the herds in the country are still outside the Scheme, especially in view of the financial inducement of the bonus for designated milk. It should not be a question of buildings because in general the Milk and Dairies Order is taken as the basis for the requirements in relation to buildings under the Accredited Scheme, and of course the Milk and Dairies Order should apply to all producers whether or not they are producing designated milk. On the whole, landlords are willing to undertake necessary and reasonable alterations and improvements to the buildings, and if they desire they can take up loans on a long-term basis for this purpose. In Wiltshire, the Small Holdings Committee undertake to carry out any alterations to buildings where the tenant is desirous of obtaining a licence to produce Accredited Milk. The usual requirements are adequate light, ventilation and an impervious floor, all of which are necessary

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for the good health of the cattle. It is found by experience that healthy, clean and well-kept buildings are a great inducement to those who work in such surroundings to adopt clean methods and to take a pride in their work. There should, of course, be an adequate and wholesome supply of water and in some instances this is not forthcoming, although it is also a requirement under the Milk and Dairies Order.

Health of the Cattle. Up and down the country there is no doubt that the Accredited Scheme has created a great improvement on dairy farms, and what is equally important, in the health of the cattle. This is illustrated by the following observations in relation to Wiltshire.

Apart from the various regulations to be observed in the interests of clean milk production, one of the chief conditions relating to a licence to produce designated milk is that the herd must be submitted periodically to a clinical examination by a veterinary surgeon, with a view to eliminating any animals which are affected with certain scheduled diseases. From a national point of view, the improvement in the health of the cattle is very important and most farmers will agree that the regular veterinary examinations of their herds is definitely a sound policy.

The reduction in the number of cases of scheduled diseases found in licensed herds in Wiltshire since the introduction of the Accredited Scheme in 1935 is clearly shown in the following table:—

VETERINARY EXAMINATIONS OF ACCREDITED HERDS

Year	No. of Herd Examinations	No. of Cattle Examined	Scheduled Diseases		Mastitis	
			No. of Cases	%	No.	%
1935	909	43,070	1,431	3·3	1,205	2·8
1936	2,161	94,292	1,819	1·9	1,432	1·5
1937	2,357	102,637	1,754	1·7	1,427	1·4
1938	2,169	94,599	2,232	2·3	1,736	1·8

These statistics are very interesting as they show an appreciable decline in the number of cases of scheduled diseases found in Accredited herds until 1938, when there appears to have been a setback. This was due to the serious epidemic of foot-and-mouth disease during the first three months of the year, which necessitated a complete stoppage of the veterinary



FIG. 1. A reconstructed cowshed, with a good yard. Note roof lighting and ventilation. The dairy is on the left.



FIG. 2. The interior of Shed shown in Fig. 1. Note the effect of the roof lighting.



FIG. 3 Washing up and sterilizing facilities should be ample and well arranged

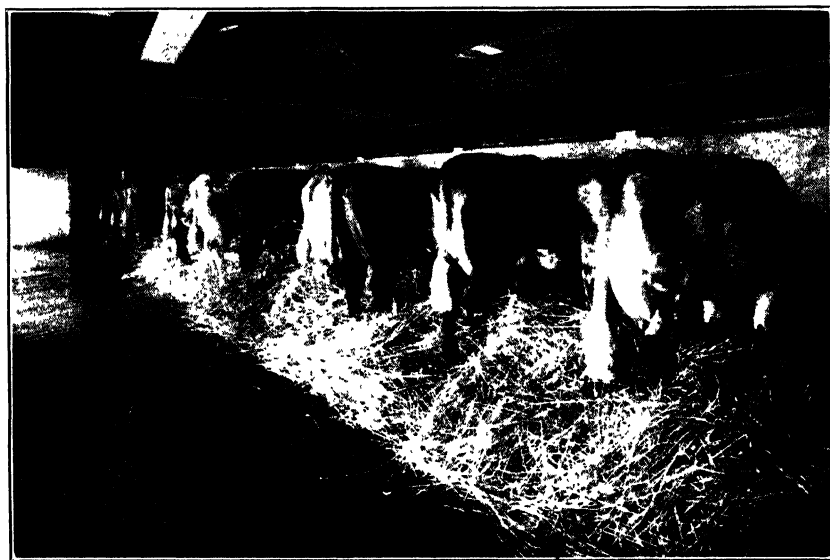


FIG. 4 A good bed of straw makes for comfort and cleanliness. Cows bedded down after milking

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work in the county. When the examinations were resumed, it was found that failure on the part of the farmers to discover and isolate cases of mastitis and other scheduled diseases during the epidemic had resulted in a temporary setback to the good work that had been accomplished. The lesson to be drawn from this experience is that herd owners should act more on their own initiative in isolating affected animals and not wait for the veterinary surgeon to give them instructions to do so. Mastitis is still the cause of much loss to the industry, and it will be seen from the tables that nearly 80 per cent. of the animals affected with diseases specified under the Order were found to be suffering from mastitis. Farmers should realize that prevention is the only way of tackling this problem, and by prompt action valuable cows can be saved and the trouble prevented from spreading to other members of the herd. It is also pleasing to record that in 50 per cent. of the herds examined during the past two years, no evidence of any scheduled diseases was found.

Importance of Inspection. Methods of production play the most important part and should receive primary consideration. Where only a limited number of milk samples can be examined, inspection of methods is essential; also with the change-over from the bacteriological examination of milk samples to the Methylene Blue test, little evidence is forthcoming as to the cause of any contamination, particularly if pathogenic. The taking of a large number of milk samples at frequent intervals is impracticable and costly, although this can to some extent be overcome by taking as many samples as possible at the milk depot or railway station instead of visiting the individual farms for this purpose. It is quite possible at a milk depot to take as many as 80-100 samples during the morning, as the milk is delivered. During very hot weather the results of the Methylene Blue test may not be very reliable owing to high temperature during transit of the samples, and although this may be avoided by packing them in ice, the cost incurred when dealing with a large number of samples makes it almost impracticable.

For standardized output the easier method is to look after and inspect the "machine," but with the human and animal factors routine inspection is even more necessary than with the automatic machine. As an example, a producer under the Weights and Measures Act has to ensure that the scales

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and other measures are kept in accurate order and these are regularly inspected and checked with the reasonable assumption that the majority of goods supplied are of the correct weight or measure. There is nothing difficult or mysterious in the employment of methods suitable for the production of hygienic milk. It is just a question of routine and thorough attention to detail, and may be summed up in the maintenance of cleanliness of cattle, sheds, milkers and milking, sterilizing of utensils and efficient cooling. In Wiltshire, one Inspector (Assistant Dairy Instructor) is allocated to each 250 herds producing designated milk, and his duties, in addition to inspecting, include advisory work and the collection of milk samples at the depots or farms.

Equipment and Utensils. The inefficient cleaning and sterilizing of milk utensils are among the main reasons why producers obtain bad results on their milk samples. The bacteria that cause scouring, off-flavours, etc., grow and multiply very rapidly on the moist surfaces of untreated or improperly treated milking pails, receivers, coolers, etc. Although the utensils may appear to have been well washed, they are not really clean unless most of the bacteria have been killed, and this can only be done by subjection to a high temperature. It is the heat that destroys bacteria, and not the steam, the latter only being the means of supplying heat to the utensils.

The quantity and type of equipment required in washing and sterilizing dairy utensils depend on the size of the dairy. Small dairies usually only require simple equipment, but in the larger dairies the use of more elaborate equipment is more economical.

The washing procedure is simple and should be conscientiously carried out every day. First of all, remove with cold or lukewarm water as much as possible of the foreign material, milk or cream adhering to the surface of the utensils. This preliminary rinsing makes the subsequent washing much easier and more effective. All remaining foreign matter is then removed by scrubbing with a brush, hot water and an alkali or soda washing powder. The washing water should be about as hot as the hands will bear. The amount of washing powder required will vary with the hardness of the water and the kind of powder. Enough should be used to "break" the water so that grease may be removed from the utensils. Rags and cloths should not be used because they are difficult to free

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from bacteria and tend to smear grease and other foreign matter instead of loosening it as a brush does. The washing should be done in a galvanized iron, round-bottomed trough, which is greatly preferable to the old wooden tub that is still used on many farms.

After washing, the utensils should be rinsed in clean water, and then placed in the sterilizing cabinet. Pails, bottles, receivers, etc., should be placed in an inverted position, as in this way they heat up quicker and the condensed steam drains from them. Steaming should last as long as is necessary to obtain a temperature of at least 210° F. in the chest, and this temperature should be maintained for at least ten minutes. This treatment will effectively kill all bacteria and should ensure good milk sample results.

The question of the size of the boiler is important, and generally speaking it will be found that a boiler capable of a steam pressure of 30-50 lb. is more economical on farms where milking machines are used, or where the size of the herd is such that a good number of utensils is necessary. For smaller dairies a lower pressure boiler of about 15 lb. gauge pressure is quite sufficient.

On farms where trouble has been experienced with unsterile milk churns, it is advisable to install a steam jet over which they can be sterilized. The effectiveness of the jet depends on the steam pressure used, the size of the opening through which the steam is ejected, and the length of time the churns are steamed. As a general rule, the churns should be steamed until they are too hot to handle with bare hands. After this treatment they will dry from their own heat if placed right side up and left uncovered for a few minutes before they are inverted on the rack.

The same treatment can be applied to the teat cups and rubbers of the milking machine. Special jets should be fitted to the steam pipe to which the rubber milk line can be attached and the steam allowed to play through the whole of the teat cluster for at least five minutes. This treatment is as effective as placing the parts in the sterilizing chest, and less harmful to the rubber.

With the labour problem becoming acute in many districts, milk producers are turning their attention to machine milking, and it cannot be too strongly emphasized that the success of machine milking in any herd depends to a very large extent on the way in which the machine is managed, washed and steril-

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ized. Failure to cleanse the machine properly every day will inevitably result in milk sample failures.

Water Supply. The dairy water supply is very important. Contaminated water may be a source of danger to the health not only of those on the farm, but to all those who use the milk from the farm. In many parts of the country the water supply is an acute problem, but it should be remembered that one of the first essentials on a dairy farm is clean, safe water.

Cooling. Milk cooling is another important feature, particularly during the summer months. It has been found that many farmers are inclined to hurry through this operation or not use sufficient water for cooling purposes. It is always advisable to have a dairy thermometer handy and frequently to check up the efficiency of the cooling by taking the temperature of the water as it enters the cooler, and the temperature of the milk in the churn after cooling. There should not be more than 5° F. difference in the two temperatures. Retarding the flow of milk and increasing the water pressure will very often bring the difference down to 3° F.

Farm Buildings. Differences in the standards laid down by Local Authorities for cowsheds and dairies have resulted in undue publicity being given to this aspect of the Accredited Milk Scheme. This is unfortunate, as many farmers have formed the opinion that the alterations may be costly and unnecessary. There are very few cowsheds that cannot be made to conform—at a comparatively small cost—to the essential requirements affecting the health of the cattle and the clean conditions necessary for the production of milk. Ample light and ventilation, impervious floors and outside drainage are points which should be considered as affecting the health of the cattle, especially if they have to spend the greater part of the winter months indoors. In a great many instances, glass tiles, let in the roof, are all that is required to provide additional light, and the raising of ridge tiles will effect a marked improvement in the ventilation of any shed. Concrete, in spite of its many disadvantages, is still the most suitable material for floors and it is, of course, a distinct advantage to have a short standing of from 4 ft. 9 in. to 5 ft. 3 in. (depending on the size of the cows) together with a low manger front and a drop of at least 6 in. to the manure channel. The latter is a point

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of much contention among authorities, but the consensus of opinion is that a manure channel must be at least 2 ft. 6 in. wide if it is to be of any use.

Such improvements as wall rendering and the protection with sheet tin of woodwork liable to dung splashing are well worth while and inexpensive to carry out—they reduce the amount of work required to keep the sheds in a clean condition.

Dairies should be so situated that the distance milk must be carried is reduced to a minimum. Ample light, sufficient space to work in comfort, and impervious floors are essential requirements and can be provided on most farms at very little cost.

It cannot be too strongly emphasized that cleanliness is the main factor, and no matter what expenditure is incurred in alterations no advantage will accrue unless a definite routine of cleaning is laid down and followed conscientiously.

SCIENCE AND THE FARMER—II: THE FOOD OF THE PLANT

J. A. SCOTT WATSON,

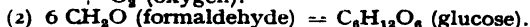
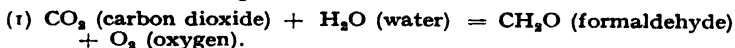
School of Rural Economy, Oxford University

Long before the day of agricultural science the farmer had discovered for himself that certain substances, applied to the soil, improved the growth of plants. Some of these—dung, wood ashes and leaf mould—were derived from plants; others, like bones and wool shoddy, came from animals; still others were minerals—for instance lime and marl. Various of the early agricultural writers tried to fit the known facts into some kind of theory of manuring, but with no real success.

It was only about a hundred years ago that chemists began to be able to identify the various chemical elements of which plants are composed; when this became possible it was a natural step to try to discover whence these elements came, and which of them were important in relation to the fertility of the soil.

The early notion had been that the plant fed upon organic matter—the dead remains of other plants and animals. This, of course, is true of certain kinds of plants—of mushrooms and other fungi. But, as far as concerns the ordinary green plant, Liebig, just a century ago, showed fairly conclusively that the bulk of its substance is derived not from the solid matter of the soil but from air and water. The commonest group of compounds in the plant—sugars, starch, cellulose (fibre), oils and fats—contain only the three elements carbon, hydrogen and oxygen. The first of these compounds to be formed in the plant is the simple sugar glucose or dextrose. This is manufactured in the green parts of the plant from carbon dioxide, taken in from the air, and water taken up by the roots. The sugar is quickly converted to starch.

The process seems to take place in two stages. In the first, the carbon dioxide and water are combined to produce formaldehyde (formalin), the surplus oxygen being returned to the air. In the second stage, which follows almost instantaneously, six molecules of formaldehyde are combined to form one molecule of glucose. The reactions are written:—



This process can be repeated by the chemist in the laboratory—sugar can be made from air and water without bringing in the plant; but, fortunately for our industry, the artificial process seems likely, for some time at least, to remain more expensive than the natural one.

In the plant, the glucose is easily converted into cane sugar (as in the sugar-beet), into starch (as in the potato), into oil (as in linseed) or into woody fibre (as in a timber tree).

Next commonest among plant compounds are the proteins which contain, besides the three elements of sugar, a substantial amount (about 16 per cent.) of nitrogen. Some proteins contain sulphur and phosphorus as well. The actual living matter of the plant—the protoplasm—has much the same gross composition as the proteins.

The source of the nitrogen in the plant was for long a matter of dispute, and the early experiments did not produce an answer. For instance, the earliest field trials with Chilean nitrate, about 1840, showed that this stuff had an astonishing effect upon the growth of wheat, but no effect whatever on clover. Eventually, about fifty years ago, the main facts were established: some of the lower plants—the yeasts and certain kinds of bacteria—can make use of the free nitrogen of the air; the ordinary green plant cannot do so, but depends upon a supply of nitrogen compounds in the soil (nitrates and ammonia); exceptionally, beans, clovers and other leguminous plants are independent of nitrogen compounds in the soil, because they live in a kind of partnership with particular strains of nitrogen-fixing bacteria.

Leaving aside nitrogen, which will be discussed in the next article of this series, the remaining food materials of the plant are mineral salts taken up, in the soil solution, by the roots. When plant material is burnt, the bulk of these minerals remains as ash; the total amount of this ash is usually not large—perhaps five per cent., by weight, of the total dry matter. The list of elements in the plant ash is a very long one; some, like calcium (lime), magnesium and phosphorus, are abundant; others, like boron and copper, occur only in minute amounts. Among all these are only a few with which the farmer, in the ordinary way, is concerned, the point being that many of them occur, in ordinary soils, in more than adequate amounts. The early experiments at Rothamsted distinguished quite clearly between those elements, like potassium and phosphorus, which are likely to be in short supply and those others, like sodium,

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magnesium and sulphur, which are usually present in abundance. Naturally, the position is not the same in all parts of the world. A few scattered instances have been found where soils contain too little sulphur for full plant growth, and there is some evidence in this country that fruit crops—especially raspberries—may suffer from a shortage of magnesium. But, broadly speaking, the results of the early Rothamsted trials apply to the world at large—the two mineral elements which most often require to be added to the soil, in order to keep it fertile, are potassium and phosphorus.

Lately, indeed, a great deal has been discovered about the "trace" or "minor" elements, which are required by the plant only in minute amounts, but which the soil may nevertheless fail to provide in sufficient quantities. Cases of zinc and copper deficiencies have been found. In parts of this country two of these trace elements, boron and manganese, are of real importance. Boron deficiency, for instance, is the cause of crown-rot in sugar-beet and of brown-heart or "raan" in swedes; manganese deficiency can be the cause of crop failures, more especially with oats and most frequently on land that has been heavily limed. With such soils a dressing of a few pounds per acre of borax, or of manganese sulphate, will generally put matters right.

In other soils the deficiency of a minor element shows not in the plant but in the animal which feeds upon the plant. Thus within the last two years it has been shown that "swayback" in lambs is caused by a deficiency of copper in the herbage upon which the pregnant ewe has been fed, and that a pining disease of sheep, common in parts of the Cheviots, is due to the failure of the pastures to provide the necessary trace of cobalt. Here again the remedy, once the nature of the trouble has been discovered, is usually cheap and easy.

The important mineral fertilizers are those supplying potassium and phosphorus.

Potash. The exact function of potash in the plant is not understood, but it is in some way connected with the efficiency of the process of starch formation in the leaf. Potash deficiency often shows itself in the form of "leaf-scorch" in which the tips and edges of the leaves turn brown and die. Potash occurs in most ordinary rocks, in the form of such minerals as felspars and micas; in soils formed from such rocks—for example boulder clays derived from granite—the total amount of potash may amount to many tons per acre. The potash in

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these minerals is, however, insoluble and unavailable, and is set free only slowly as the minerals are weathered.

The simple salts of potash which are used as fertilizers (the sulphate, muriate or chloride and the nitrate) are all very soluble in water and therefore no question arises of any difference in their availability to the plant. Some of our potash fertilizers (sulphate of potash and muriate of potash) are practically pure salts, and here any difference in their action depends upon the acid radicle (sulphate or chloride) with which the potash is combined. The chloride may be harmful to certain crops (potatoes and fruit) if large applications are made. Others of the potash fertilizers are impure, the bulk of the impurity being common salt. The salt may be useful, as sometimes with mangolds, sugar-beet, barley and grass; or harmful, as it is to potatoes. But always where we apply an ordinary potash fertilizer, we are adding a water-soluble salt, and the effect upon the potash status of the soil will be substantially the same.

The fate of potash applied to the soil is not what might be expected. If, for instance, we apply the chloride, and the soil is washed with rain water, the chlorine passes out in the drainage water, while the potash combines with the clay of the soil and pushes out other bases. This is clearly shown by the Aberdeen experiments with drain gauges, which are enclosed blocks of soil from which the whole of the drainage water can be collected. In one such experiment one block of soil was left unmanured while the other had, over a period of years, applications of muriate of potash amounting to about five hundredweight per acre. The results were:—

	<i>Unmanured</i>	<i>Muriate of Potash</i>	<i>Difference</i>
CHLORINE (lb. per acre) .			
Applied	0	273	273
Found in drainage water	41	317	276
POTASH (lb. per acre) :			
Applied	0	272	272
Found in drainage water	10	13	3
OTHER BASES (lb. per acre) .			
Found in drainage water :			
Lime	167	345	178
Magnesia	41	84	43
Soda	102	152	50
Total	310	581	271

The conclusion is thus that, of 272 lb. of potash applied to the soil, only 3 lb. was washed out; for the rest the effect of the

potash was to push out of the soil, and into the drainage water, 271 lb. of the other bases—lime, magnesia and soda.

This is an example of *base exchange*; the principle is that which is used in the common permutite process of water softening, where the lime salts are taken out of the water by a soda compound; when the latter has given up its soda and is full of lime, it is drenched with common salt, and the limey water which comes off is run to waste.

There is no doubt that the retention of potash by the soil depends upon the action of the colloidal clay, but even an ordinarily sandy soil contains enough clay to prevent any serious loss. This is all to the good. But it must be remembered that the tenacity with which potash is held by the soil is a disadvantage under certain conditions. For instance, if we give a top dressing of sulphate of potash to an apple orchard on clay soil, it will be a matter of years before the potash is washed down into the soil zone where the feeding roots of the trees are situated. In such circumstances it may be an advantage to plough in the dressing. There is also some evidence that the ploughing-in of potash is an advantage with the deeper-rooting annual crops, such as sugar-beet. It also seems that, under certain conditions, part of the potash that we apply may be so firmly held that the plant is not able to extract it from the soil. It is however with phosphates, and not with potash, that this problem of conversion from an available to a non-available form is of practical importance.

Phosphates. The ordinary phosphatic fertilizers are phosphates of lime. The acid lime phosphate that is produced by treating ordinary mineral phosphate with sulphuric acid (superphosphate) is soluble in water. In certain other manures—bone meal, bone flour, and “high-soluble” basic slags—the phosphate is insoluble in water but fairly soluble in dilute weak acid. One-per-cent. citric acid is used in testing. Still other forms, like the “low-soluble” slags and ground mineral phosphate, are only slightly soluble in weak acid.

Even a water-soluble phosphate is not lost, by drainage, from an ordinary soil. There may indeed be loss from a very shallow stony soil upon a steep slope, but the likelihood here is that the phosphate is washed away as small solid particles in running water, rather than in solution by drainage. In the Aberdeen drain-gauge experiments the unmanured block lost, in the drainage water, only a fraction of a pound of phosphoric

acid per acre per year, and the application of half a ton of superphosphate, over a period of years, did not increase this loss. Indeed the problem of phosphatic manuring is that the soil tends to take up phosphate and hold it so firmly that the plant roots are unable to extract it. Were this not so, we could farm with much lower applications of phosphate than those which we commonly use. A single hundredweight of superphosphate contains as much phosphoric acid as is removed from the soil by an ordinary crop of wheat or swedes, and considerably more than that removed by an average crop of hay. Actually there are parts of the world where very light dressings are quite as effective as could be expected. In parts of Australia and Africa remarkable responses, both with pasture and with arable crops, can be obtained from applications of half a hundredweight of superphosphate per acre. In this country, on the other hand, really deficient soils may give little or no response to applications of less than five or six hundredweight, and half a ton is necessary under some conditions.

Professor Hanley has investigated the position in connexion with the famous Tree Field experiment at Cockle Park. Plot 4 of the trial has had an application of 5 cwt. of basic slag per acre every third year during the last forty, or a total of 65 cwt. per acre. Of this amount only about 5 cwt. can be accounted for in the bones of the sheep that have been fed and grown upon the plot. About 59 cwt. of the slag, or at least of the phosphate which it contained, is still lying in the top nine inches of soil; and yet the plot continues to respond to fresh applications. The appetite of the soil for phosphate seems to be insatiable.

This problem was rather fully discussed by F. Hanley in the May number of this *Journal* and it seems unnecessary to cover the ground again. The main points are:—

- (1) In lime-deficient soils, water-soluble phosphate is liable to combine with iron and alumina, giving very insoluble and therefore unavailable compounds. At the other extreme, on very chalky soils, the compounds that are formed also tend to be rather highly insoluble; the fullest utilization of superphosphate is obtained on soils with a moderate lime content.
- (2) The least soluble phosphatic fertilizers (ground mineral phosphate and low-soluble slag) give very poor results on neutral or alkaline soils. On rather acid land they may produce nearly as good responses as high-soluble slags.
- (3) Where the soil has a strong tendency to fix phosphate in a non-available form, there is an argument, in theory at least *against*

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mixing the phosphate intimately with the soil. If we drill the fertilizer in narrow bands, and bury it some distance below the surface, we may succeed in eliminating, to some extent, the competition for phosphate between the soil and the plant.

Testing Soil for available Potash and Phosphate. The same kind of process that is applied to a basic slag—the measurement of its solubility in weak acid—may be applied to the soil. The result obtained is expressed by the chemist as “available phosphate” or “available potash” as the case may be. Besides such methods of chemical analysis, there are various biological tests, in which the chemist seeks the assistance of a growing plant in his endeavour to estimate the amounts of available nutrients in the soil.

An example of the latter is the Neubauer seedling method. In this, a sample of the soil is mixed with a fixed proportion of sand, and rye is sown in a pot of the mixture. The seedlings are allowed to grow, in a greenhouse at a carefully regulated temperature, for 17 days. On the eighteenth day the rye shoots are removed and are analysed for potash and phosphate. It is known that a properly nourished plant of rye, at this stage of growth, contains certain percentages of potash and phosphate, and the basis of the test is the assumption that any deficiency of either, in the soil, will be reflected in the composition of the plant.

It would be very helpful to the farmer if a quick and cheap test of this sort could tell him how to manure a particular crop on a particular field. Unfortunately it seems that no one of the known methods can give the information that is required. Every method is liable, at times, to lead to conclusions that are contradicted by actual experiments in the field. The figures arrived at in the laboratory can never be taken at their simple face value, but require to be interpreted by someone who knows the behaviour of the particular type of soil and of the particular crop that it is proposed to grow. On the latter point alone we know, for instance, that certain forms of soil phosphate that are available to a swede plant may be unavailable to the potato; on phosphate-deficient land swedes will generally respond to either ground mineral phosphate or to superphosphate, whereas potatoes will benefit from the latter but not from the former.

Doubtless, in time, we shall get to the position when we shall be able to base our use of fertilizers on laboratory tests of our soils. But that stage has not yet been reached.

STARTING A FLOWER FARM

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As far back as I can remember, one of my ambitions has always been to own a flower farm. Fortunately, I realized that a great deal of experience and a certain amount of capital were necessary to make a success of such a venture. To these two essentials must be added a third—a capacity for hard work.

My Cornish farm, approximately twelve acres in extent, is divided into eight small fields on which stood two old cobb cottages. The farm is situated half a mile from the main Truro to Falmouth road and has a gentle slope to the south; the soil is a medium loam with a killas slate subsoil.

The farm, with the two cottages but without any adequate buildings, was purchased for approximately £900. I took possession in October, 1933, after consulting a well-known grower, who gave the sound but rather depressing advice for me to make sure that it was saleable in the event of my failing to make good. The cottages were converted into one large one with necessary amenities for an additional £100. Stock, consisting of bulbs and plants, accounted for £170. Dutch lights cost £10, and £20 was spent on a second-hand shed. With the exception of essential tools there was no further outlay; subsequent stocks and equipment have all been purchased out of income. Money has never been spent on buildings or equipment without due consideration, and every endeavour has been made to arrange for both buildings and equipment to serve more than one purpose.

For the first two years I endeavoured to find out whether mechanical or horse labour was the better proposition. Subsequent experience has shown me that I would have saved myself trouble and worry if I had invested in a rototiller at the commencement. I hired horses and ponies from the neighbouring farmers, which enabled me to accomplish the work; but it is undoubtedly preferable to be independent, and so I finally decided on a rototiller, which has already more than paid for itself. This small machine has not been found suitable by all growers. In some soils it has a tendency to

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produce too fine a tilth for certain crops. For the preparation of the anemone ground, which needs very good cultivation, and for working between the strawberry rows, enabling the fine soil to be worked well round the crowns of the plants, I find it almost indispensable. On a large farm with larger units, a horse might be found more economical, but on my small farm composed of small units the headlands would have to be cultivated by hand, and there is besides the damage caused to adjacent crops in turning horses.

After four years I purchased a tractor for ploughing, rolling and harrowing. When the tractor industry has specialized and perfected the small tractors to the same extent as the larger models, cultivation will be an easier job for the smallholder.

With the exception of contract ploughing by a Fordson for areas of an acre or over, the farm is independent of outside assistance.

A trailer attachment for the car has been a valuable asset. It is capable of carrying up to 5 cwt., and apart from transport of flowers to the station, it is used for the collection of small quantities of manures and for farm cartage in dry weather. A tool which I would not like to dispense with is the wheel hoe, of which there are several makes on the market. This consists of two handles on a frame with slots to take hoe blades of different widths and runs on a wheel. The operator can cover more ground by pushing this wheel hoe in front of him between rows of plants than by the usual method of hand hoeing.

No up-to-date farm is properly equipped without its spraying outfit. I have a knapsack for liquid spray, which is used frequently, and another for occasional dusting.

The acreage is approximately divided amongst the following crops: anemones $1\frac{1}{2}$, daffodils $1\frac{1}{2}$, polyanthus 1, violets $\frac{1}{4}$, strawberries 2, raspberries $\frac{1}{2}$, blackberries and gooseberries (dessert) $\frac{1}{4}$ each.

Fifty frames with Dutch lights are used for early lettuce, carrots and French beans. One hundred and fifty continuous cloches protect violets in winter and strawberries in spring. The remainder is down to grass and let for grazing.

Besides producing cut flowers and fruit for sale, I have worked up a connection for plants of high quality, which are despatched to all parts of Great Britain. The number of strawberry plants (certified by the Ministry of Agriculture)

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sold annually varies from 50,000 to 70,000; polyanthus plants from 20,000 to 60,000; violet plants from 20,000 to 50,000, and several thousands of young raspberry canes. This source of income often puts the balance on the right side if the season has been an unfavourable one for harvesting the crops.

The year's work begins with harvesting anemones, violets, and polyanthus in October; in February the daffodils are ready, and normally all these are in bloom until the end of the flower season in May. In this month, violet and polyanthus roots are lifted for replanting or for sale; anemone planting commences; the strawberries are strawed, while the early ones under cloches are ripening for market.

In June, the outdoor strawberry crop is ready, and the raspberry crop follows in July. In August, our attention is claimed by the cultivated blackberries and by bulb lifting, sterilization and planting, which continues into September, together with strawberry lifting for sale and planting out the new beds.

The above system of cultivation is planned in such a way as to keep the work fairly constant throughout the year. Thus a permanent staff can be employed, supplemented by extra pickers during the spring flower and summer fruit seasons, and the necessity for engaging casual labour for the routine work of the farm is avoided.

My permanent staff consists of a man, woman and a boy, and in addition there are from two to four students. I always work with my staff; each worker is given the job for which he or she is best fitted. In wet weather, the change from outdoor to indoor work is made expeditiously, as one cannot afford lost time in these difficult days. In return for good work I give good wages and give my staff security of employment. However slack the season, they know they have a full-time job.

I aim at the best; there is no stinting where manures or cultivators are concerned. Owing to the nature of the farm much hand labour is necessarily incurred, but I do not grudge this as I find that, by keeping down the weeds, labour in subsequent years is reduced by more than one half.

My advice to the prospective grower, prior to choosing a farm, is to spend some time in the district he favours and make as many contacts as possible with the local growers. I myself spent several holidays in the county and received valuable help from the County Horticultural Superintendent. Small,

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compact farms with a habitable cottage are not very easily found, and the purchase price or rent, if the farm can be hired, is higher per acre than for larger farms. To reach the homestead in Cornwall it is often necessary to cross one or two fields, and a winter spent down here will bring home very forcibly to the grower the disadvantage of transport under these conditions, which can only be remedied by heavy outlay on road construction.

A farm with rather more acreage than it is intended to cultivate will allow for expansion or for a change over of fields in the event of disease or land sickness. The surplus acreage can be let for grazing.

The site is a very important consideration, since damage by wind is one of the chief dangers. An ideal farm would slope to the south and would be sheltered from the east and from the prevailing south-westerly winds. A good water supply, easy access to a road, fertile soil and reasonable immunity from frost damage are also desirable features. Other factors worth consideration are accessibility to a railway and to local shops, a supply of permanent seasonal labour, and a source of farm-yard manure within easy reach. A farm on which the crops it is intended to cultivate have not been previously grown is at least likely to be free from a legacy of possible trouble in the form of pest and disease, but an adjoining farm cultivated by an unscientific or careless grower of similar crops can be a menace.

I would like to emphasize the great importance of introducing the very best strains and stocks for the initial plantings. As regards daffodil bulbs, every effort should be made to ensure that all bulbs are efficiently sterilized, in order to eliminate any danger of importing either eelworm or bulb fly. Clonal strains of strawberry plants, and raspberry canes which are claimed to be free as far as possible from virus disease, are now distributed by Research Stations. Stocks are limited, but if a nucleus is obtained it can be enlarged by careful selection.

The question of purchase versus renting is a debatable one, and the amount of capital available will largely determine this point. Wherever possible, I advise buying outright since there is nothing like ownership for making one put one's heart and soul into the business and become the owner of something really worth while. The ideal arrangement, however, may be to begin by renting, with an option of purchase.

As a rough estimate, I have doubled my original capital of

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£1,200 in five years. Out of income I have built another house on the farm for a foreman; this also accommodates three or four students. I have also built two more packing and storage sheds, a garage and tanks for the storage of an adequate water supply to cottage and sheds. My cottage has been considerably improved. I consider the farm is now equipped with buildings, tractors and other implements sufficient to meet any normal contingencies.

Any success I have achieved I attribute to the experience which comes from being born on a large mixed farm, to having had a horticultural training followed by a varied practical experience, to having enjoyed good health and to the possession of a large capacity for hard work.

HIGH-GRADE SUMMER BEEF AND MUTTON PRODUCTION

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Thirty years ago 90 per cent. of the land in the coastal district of north Northumberland extending between Berwick and Warkworth (now producing super-grade summer beef) was farmed in the four- and five-course rotation, and producing beef and mutton in winter, oats, barley and a very little wheat. There was, however, in this region a considerable area of strong wheat land which had previously been sown down with permanent seeds, but, for lack of suitable manure for top dressing, it had reverted to a condition of non-productiveness, while a portion of it, requiring draining, had become unsafe for sheep grazing. The introduction of slag for top dressing for a time brought relief to this class of farming, but then corn production, even on the better land, became unremunerative, and increased acreages were seeded down to grass in order to curtail expenses. Wild white clover then came on to the market, with the result that after the War a good arable district was transformed into a high-class summer feeding area.

My farming is carried on in the northern half of this area, and most of it represents the farming practised in the district, except a small portion of moorland used for dry ewes in summer, and two isolated portions where cattle are allowed to run out from byres in winter. In addition I have about 180 acres of light sheep land which has tired of growing roots.

Producing a Good Pasture. When wild white clover became available I included it in the ordinary seed mixture for two or three years' ley and found the effect so marked that some pastures have not been disturbed since. The mixture used with slight variation is the one recommended by those responsible for the experiments at Cockle Park. This mixture consists chiefly of perennial ryegrass, cocksfoot, timothy and wild white clover.

Frequent dressings of slag have helped to maintain the feeding quality and carrying capacity, but even with this

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manuring most of the older pastures sown down for 10 years or more are not carrying and feeding so much stock as formerly, while those of the medium type are reverting, and other grasses and weeds indigenous to the soil are becoming established. To get over this condition we find it a profitable course to plough this up in sections and take one or two green crops, then re-seed with what I consider a rather better mixture including grasses of the recently-developed evergreen type of perennial ryegrass, cocksfoot, and timothy. These are ready to graze earlier and, being more luxuriant in growth, carry a larger head of stock, which feeds rather faster, and, more important still, the weeds are got rid of.

I like my pastures best when the grazings resemble a cricket pitch a week or ten days after being cut in a good growing season. They should always be grazed sufficiently to prevent the grasses from seeding. This seems to maintain the feeding value right through the autumn, especially if they get one or two short rests during this time. In favourable situations, and on the best pastures holding cocksfoot well, this system can be carried a further stage without ploughing.

By the use of lime and slag, for which Government assistance is available, by the application of highly concentrated manures in granulated form, of which there is a wide choice, balanced to suit all needs, and by using lime as a foundation after slag with concentrated balanced manure, the stock can be brought to maturity sooner in greater numbers and be quite as good meat when slaughtered.

This treatment restores these pastures to the same feeding texture as pastures laid down after the War and established after three or four years' growth. Lime and phosphate properly balanced help to avert the danger of pastures becoming too rank with this extra forcing manure. So many farming operations are benefited by use of lime that every effort should be made to utilize it.

The essentials for a good pasture having been provided, the next thing is to graze it properly. This always presents difficulties in both dry and wet seasons. On nearly all pastures, some parts grow faster than others, the result being rough and bare patches; there are also sheltered parts where the stock stays in stormy weather. These become fouled by extra droppings and in time, when conditions improve, they are deserted for grass which the stock likes better, with the result that the over-manured grass grows coarse, becomes neglected

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and is wasted. To encourage equal grazing, these plots are cut with a reaper once or twice in a season, and, in places where the cocksfoot has prevented the natural growth of clover, top-dressed with potassic mineral phosphate to encourage the clover. This treatment may not do much good in the first season, but afterwards the clover attracts the stock and improves the grazing. In all pastures up to 7-8 years old a time comes, about the beginning of July, when cattle seem to tire of them, and if there are hedge backs in the field they set on them and clean them up. It is not that the pasture feeds badly, but it seems to become bitter and the cattle appreciate a change if one is at hand. An ancient pasture adjoining then becomes a considerable asset for changing the stock back and forward night and morning.

Previously I referred to some light land that had tired of growing roots. This I have sown down with wild white in a temporary mixture containing timothy, cocksfoot, and perennial ryegrass. In its place I have ploughed up some very poor moor-edge stuff which tired of growing roots fifty years ago. This land had previously been well manured with slag and potash, and the patch I had in roots last year produced an exceptionally fine crop of swedes and turnips, free from any trace of disease.

Those recently sown with temporary seeds are carrying and feeding 3 heifers to 4 acres and a ewe and a pair of lambs to the acre. On light sheep farms too much wild white may become harmful, probably more for want of being grazed by cattle than anything else. If not grazed with cattle the pastures become too rank and run to seed, and eventually waste. Many develop a propensity for growing Yorkshire fog, and in the autumn assume the colour of stubbles. Sheep do not thrive under these conditions, and to keep them right a shorter rotation is preferred and a better-balanced ration produced. Even in ordinary rotation pastures sheep are much more difficult to manage now than they were a generation ago. A proportion of the land in this district and some in adjoining districts seem to be sheep-sick. However, if run thinly among cattle, the sheep do well and increase the revenue.

Stocking. Nearly all the best feeding pastures are rested during the winter months and stocking generally begins early in April with cattle. At that time it is usual to start with about a third of the quantity necessary for a full stock and

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continue gradually till full stocking is complete in May. In addition to cattle we usually graze the equivalent of one sheep to the acre and in order to keep the sheep thriving we give them a little dry food and minerals. For this purpose shearling sheep are the most suitable, but the public taste demands lamb much earlier now, so this practice has been drastically curtailed.

I have a feeding farm in Berwickshire which I still stock in this way.

Now a word about the pastures after they have been stocked. Owing to weather conditions we frequently have considerable difficulty in regulating the stocking at the beginning of the season. Last year, for instance, we had a remarkable March with soft west winds all the time and grass a full bite early in the month—so far forward, in fact, that we began stocking at the equinox and continued increasing till April. There followed a drought which lasted well into May and curtailed our buying till the selling season began early in June, when we had rain in abundance. This year we had a good March and good growing, and commenced stocking early. In April we had winter weather with the wind blowing from the north and east continually, holding up the vegetation, with a result that many fields made no progress for more than a month. These happenings would be serious if experience of this climate had not taught us to use a certain amount of caution and provide at least for some unexpected shocks which come to us. Gradual stocking saves us from many pitfalls.

Stores. We now come to what is the most important part of this business, viz., buying or breeding suitable stores which will grow and fatten into high-grade beef and command the interest of the best buyers in the trade when they are presented at the grading centres.

It is now recognized that Aberdeen-Angus-crosses, or pure Aberdeen-Angus have proved themselves to be the breeds competent to claim this market.

In our local market from June to December quite 90 per cent. of the cattle offered are this breed. More than that, the type of the breed is becoming standardized, as a great preponderance of the animals marketed weigh $8\frac{1}{2}$ -10 cwt.; all are quality grade, and nearly all heifers.

It often occurs to me when I see West of Ireland breeding stock that the producers must exercise exceptional care when

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selecting them. I think, however, that in this process there is a danger of sacrificing size for quality.

In my experience this class of cattle has lost considerably in weight since the War, and they are no better for the best commercial trade, although they are preferred for high-class West End shops.

In order to produce super-quality beef it is essential to buy or produce super-quality stores. As the home-bred Aberdeen-Angus-cross calves reared on the Scottish border and the south of Scotland are largely bought for winter feeding in Scotland, and since home-bred calves are seldom good enough, being bred from milk strains, we have to rely almost entirely on West of Ireland Aberdeen-Angus-crosses for our supplies; and as many feeders prefer heifers a very large proportion of the surplus comes to our local markets. We also get a few bullocks, but most of them go to central Scotland markets.

With the feeding area increasing, the problem of getting suitable stores has become difficult. I often think many of us would be well set up if we had breeding farms capable of producing about a third of our requirements.

Probably more consideration has been given to producing super-grade stock to feed inside as calves and yearlings than to the problem of producing a first-grade heavier animal under natural conditions with very little artificial food to come out prime grass-fed beef at 2-2½ years old. The same number of cows would produce an increased weight of beef, the purchased feeding-stuffs account would be small, and the ratio of cow beef to super-grade would be reduced. There seems to be need for more research into this economic problem.

Preparation for Market. Preparing cattle for good-class commercial trade is about the last important point.

I have said for a long time that to produce the maximum amount and best quality of beef, it is essential to buy the best animals and start them on the road as soon as they are brought home.

For June and July markets we prefer cattle with calf or two teeth, bought in May or June the previous year, so that they have twelve months on the farm before coming out finished beef.

Through the summer and early winter they are grazed where more sheep are carried and they grow and improve naturally until many are three parts beef in November and

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December. They are then housed at night, either in folds or byres, are given hay and go out to poor pasture for exercise during the day. If the hay given them has not been well made or has been damaged by weather they receive 3-4 lb. per day of a mixture of earthnut cake, cotton cake, grains and crushed oats. They hold their condition under this treatment, and when April comes we begin turning them into the pastures which have had the longest rest. We keep buying stores for wintering until September or October, when we have no more winter accommodation.

Invariably the earliest bought are the first to go off fat and, generally speaking, the June and July markets are the best during which to sell. We therefore try to sell as many as possible during these months.

As a rule we begin spring buying early in March. The animals then purchased have been outwintered in Ireland, otherwise we should have to shelter them indoors. As it is, we endeavour to find them shelter for a few nights on arrival. Afterwards they are fed with hay in the open. This process goes on till the buying season ends in May or June. Some get roots in addition to hay when we have roots to spare. The new stock follow the wintered cattle on the best pastures. Farmers who feed cattle of their own breeding or other home-bred animals bought locally aim at a similar type, and have the advantage that the calves are suckled, and condition is preserved after they are weaned by the use of a little linseed cake in the feeding mixture, with good hay. These animals are grazed another summer on second-rate land and wintered again with foods similar to that given to the Irish cattle. It is important that both sire and dam should be good if the best type of feeding animal is to be produced.

There are still considerable areas where farms conducted in this manner can be made to yield increased quantities of home-produced food, but considerably more capital is required than is being used at the present time. My own enthusiasm has occasionally resulted in an improvement which necessitated a greater outlay of capital than I anticipated.

On the ability of the farmer to select and purchase at its market value the type of animal best suited for the kind of grazing described, the success or otherwise of the enterprise depends.

THE CONTROL OF POTATO SLUGS

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Introduction. The problem of slugs injurious to potatoes growing in the field has been one of primary concern to Lothian farmers for several years. Annual losses of 1-4 tons of potatoes per acre as a result of slug activity are not uncommon. Naturally, such losses could not be neglected, and in 1934 an investigation of the problem was undertaken by the Edinburgh and East of Scotland College of Agriculture with the help of a grant made by the Agricultural Research Council. The work was commenced by Dr. R. Carrick, who made an intensive study of the life history and development of the Grey Field Slug and of the habits and control of this and other field slugs. On Dr. Carrick's resignation, the investigation was continued by Mr. J. M. Esslemont, who concerned himself chiefly with the question of slug-control in the potato-growing areas of the Lothians.

Injurious Potato Slugs. In the Lothians there are five kinds of slug that commonly occur in fields and gardens, namely, (1) the Grey Field Slug (*Agriolimax agrestis*), (2) the Banded Grey Slug (*Arion circumscriptus*), (3) the Dusky Slug (*Arion subfuscus*), (4) the Garden Slug (*Arion hortensis*), and (5) the Hedgehog Slug (*Arion intermedius*). Of these, the Grey Field Slug is by far the most abundant and of greatest economic importance. Next to it comes the Banded Grey Slug, which, in some localities, is as destructive as the Grey Field Slug. As far as the potato crop is concerned, the remaining slugs are of minor importance.

The Grey Field Slug (Fig. 1) is the mollusc which occurs most frequently in arable land, but it is also equally at home in woods, gardens, pastures, moors and marshes. Although of a somewhat variable appearance, the Grey Field Slug is usually recognized by its whitish or pale yellow colour, mottled with brown or black. When extended, the full-grown slug measures $1\frac{1}{2}$ in. Stretching forward from the head are two pairs of black retractable feelers. Over about one-third of the upper surface there is a fold of skin, the mantle or shield, smoother than the rest, which encloses the breathing cavity.

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The breathing pore which gives access to this cavity is situated at the margin of the mantle on the right side. It is well behind the middle of the latter and is encircled by a raised white ring. When irritated, the Grey Field Slug secretes a large quantity of milk-white slime, a habit which is common to all slugs.

The Banded Grey Slug (Fig. 2) is broader than the Grey Field Slug and has a skin of more delicate texture. It is greyish-black with bluish-grey sides. Along each side of the body there is a black band and sometimes a faint orange band below it. The sole of the foot is white. The length of the slug extended is $1\frac{1}{4}$ in. In contrast to the Grey Field Slug, the breathing pore has an anterior position on the right-hand margin of the mantle. Compared with the darker coloured Garden Slug (*A. hortensis*), the Banded Grey Slug is less slimy and broader in proportion to its length. The former, too, has a yellow foot and secretes a slime that is very sticky and yellow like that of the Banded Grey Slug.

Life-history of the Grey Field Slug. The life of the Grey Field Slug is 12-15 months and consists of two phases, the first being one of growth, during which it increases in length from about $\frac{1}{8}$ in. at the time of hatching to 1 in. four to six months later. There then follows the second or breeding phase, when the slug begins egg-laying and continues the process until near the end of its natural existence. Whilst breeding may proceed throughout the whole year, it assumes its greatest intensity during late summer and autumn when temperatures of 50-68°F. combined with humidities of 40-80 per cent. provide conditions ideal for the general activities of slugs. The low temperatures of winter and the high temperatures of mid-summer merely serve to induce a temporary cessation of breeding that is resumed with the return of more favourable conditions. In Britain the lethal effect of climatic extremes on slugs is practically zero, since their well-developed habit of subterranean burrowing amply protects them against the injurious influence of such extremes.

The spherical eggs of the Grey Field Slug are laid during the night in small batches of 10-30 in crevices of the soil about an inch below the surface. Each egg is enclosed in a transparent gelatinous envelope. In leas they are found at the roots of grasses, and in arable land at the roots of potatoes, turnips and other similar crops. They are also to be found in

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farm manure that is spread on stubble and, indeed, under any object or material lying on the ground, such as sacking, where an atmosphere of high humidity is maintained.

The time required by the eggs for hatching varies with the time of year. In August, hatching occurs in 3-4 weeks, whilst eggs laid in December do not hatch in less than three months. From the egg there emerges a young slug that is identical in form with the parent, of which it is, in fact, a miniature edition. In the life-cycle of the slug there is not a larval stage, and there is therefore no metamorphosis comparable to that of insects. Development, accordingly, occurs by a slow process of growth and differentiation.

Slugs and their Environment. The success of an animal may be gauged by the average density of its population and the extent of its distribution. According to these criteria, the Grey Field Slug must be considered to have achieved a high degree of success, since it occurs locally in densities of several thousand per acre. In a stubble field in winter the slug population has been computed at more than 100,000 adults and 150,000 eggs per acre.

So far as distribution is concerned, the Grey Field Slug is widely spread in Europe, Asia, S. Africa, America, Australia, and New Zealand. By comparison, the Banded Grey Slug is much more restricted; outside of central and northern Europe it has been recorded in a few localities in North America, where it has been introduced. Under certain conditions it undergoes local increases of its numbers, but whereas the Grey Field Slug is distributed throughout the lowland potato districts of the Lothians, the Banded Grey Slug is important as a pest only in the neighbourhood of Queensferry and North Berwick.

Part of the success of the Grey Field Slug must be attributed to its omnivorous habit. It shows little discrimination in its choice of food, which includes all kinds of farm crops, garden plants and weeds. As a result it is practically ubiquitous, but is absent in places subject to drought, or exposure to the direct rays of the sun. Its environment, therefore, is one that is highly charged with moisture. This explains why slugs are most abundant on heavy clay soils with a high capacity for moisture. Such soils are prevalent on lowland Lothian farms, where conservation of moisture is further encouraged by their high organic content. That moisture is all important is shown by the annual fluctuation of the slug population



FIG. 1. The Grey Field Slug. Three quarters actual size.



FIG. 2. The Banded Grey Slug. Three quarters actual size.

NOTE. Both photographs show slugs on cut surfaces of damaged potatoes.

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according as the rainfall is above or below the average of 27 in.

Temperature, too, has important limiting effects on slugs, but since the range of temperature over which the Grey Field Slug can pursue its activities extends from just below freezing to about 70°F., it is not likely to suffer any serious inconvenience on account of temperature over the greater part of its recorded area of distribution.

Slug Habits. During the day slugs are little in evidence unless the weather be dull and wet. Usually they retire into crevices of the soil, under clods and stones, coming to the surface at nights, but only on such nights as are damp, still and rainless. Even so, the individuals of a slug population do not respond uniformly to what are apparently favourable conditions at the surface, and it is probable that at any one time only a part of the total population appears on top of the soil. Hence it is important in controlling slugs by direct methods to select for the application of poisons an evening when there is an abundance of slugs at the surface. This can be judged only by actual observation.

Many observers have remarked upon the low level of sensory response displayed by slugs. To my mind this is a natural corollary to their habit of indiscriminate feeding and underground burrowing. Normally they are hatched into an environment where there is no lack of food, so that it is unnecessary for them to discover it by active search. This may explain why slugs deprived of food for several days may fail to find a suitable supply near at hand except by mere chance.

Although different kinds of slugs are fairly uniform in behaviour, the Banded Grey Slug differs from the Grey Field Slug in two conspicuous features. In the first place, it prefers to feed underground rather than on the surface, and secondly, it is gregarious in its habits and more sluggish than the Grey Field Slug. In localities favourable to its occurrence it is frequently found in communities of about a dozen under stones, decaying vegetation, and old rejected sacks, indeed, under any object that offers requisite cover and shelter.

Damage Due to Slugs. In the Lothians, slugs have achieved their present position of economic importance because of their attacks on potato tubers in the field, and subsequently in the storage pits. Since the first attack occurs

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near the end of September only late varieties of potatoes are affected. Whilst one variety is as liable to attack as another, Golden Wonder is perhaps most seriously damaged, after which come King Edward, Kerr's Pink, and Great Scot in descending order of injury. To obviate slug-damage, some growers harvest the crop whilst the haulms are still green and before the attack has begun. The onset of the attack is associated with a change in the feeding habits of slugs during late September and early October. Previously their food has consisted of fresh potato foliage. As the season advances this gradually loses its nutritious and succulent properties and resort is then had to the tubers underground.

Potatoes damaged by the Grey Field Slug are characterized by small holes on the outside, which give access to the inner burrows. The general surface is not otherwise affected, and the holes may be so obscured by adherent soil that they are readily overlooked. Tubers that have been attacked by the banded Grey Slug, on the other hand, are recognized by entrance holes that are larger and more conspicuous, whilst large parts of the surface are eaten away. This slug, too, persists inside the damaged tuber, which it continues to excavate until the burrow is enlarged into an irregular cavity. Unlike the Grey Field Slug, which seldom remains in the tubers, the Banded Grey Slug is transported with them to the pit and there continues its destructive activities.

Although the potato crop suffers greater damage from slugs than any other in the Lothians, there are some years in which root and cereal crops are also severely attacked, particularly in the seedling stage.

Cause of Slug Infestation. Slug infestation of the potato crop in the Lothians is primarily traceable to the system of manuring in practice there. At a convenient time in autumn or early winter a liberal supply of dung at the rate of 10-20 tons per acre, is laid down on adjacent stubble fields as a preliminary to their preparation for the planting of next year's crop. With the lifting of the tubers of the current year's crop, the slug population is bereft of its normal food supply and so it slowly but gradually disperses to neighbouring fields, including those that have been recently dunged for potatoes. Thus the stubble becomes populated by chance migrants which duly increase, since dung offers ideal conditions for breeding and feeding during the winter and spring months.

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This increase proceeds until it reaches a climax in the autumn on the potato crop. There is, however, one important limiting factor which retards the increase and may render the attack negligible—namely, a deficiency of precipitation, especially in the late summer. It has been shown by Dr. Carrick that if the precipitation for the year is below 27 in., an attack of serious proportions does not arise. Rainfall, it must be recalled, determines the amount of soil moisture, which is important at the time of intensive breeding in autumn.

Control. Under the present system of heavy dunging on Lothian potato farms, exercise of effective measures of control is not easy. We have seen how slugs are encouraged by dung lying exposed on stubble during winter, and how farm manure helps to conserve moisture in soils that are already quite retentive of water necessary to slugs. It is realized that a manurial system which gives yields of 10-12 tons of potatoes per acre cannot be readily surrendered even on account of slug-damage. Nevertheless, some alleviation of the situation might be obtained by postponing the spreading of the dung on stubble until well after the current year's crop is lifted. This would have the effect of reducing the amount of winter-breeding of slugs. Further, the ploughing-under of the dung soon after it has been spread would render it less attractive to the pest.

It is apparent, however, that control cannot be expected by adoption of only slight modifications of the system of manuring and so recourse must be had to more direct methods of dealing with slugs, involving the use of contact and stomach poisons. Among these, copper sulphate has long been known as a lethal agent for slugs. In a 3 per cent. solution in water it is applied as a spray, or alternatively it can be mixed with kaint in the proportion of 1 part of sulphate to 18 of kaint by weight and applied dry at the rate of 3 cwt. per acre. To be effective the sulphate must be dusted directly on the slug, and, as slugs are nocturnal, the treatment must be made at night. Copper sulphate has one great drawback in that it causes serious scorching of the foliage with which it comes into contact. It is, therefore, not practicable to apply it to standing crops. The time most suitable for application is after the crop has been lifted, when the slugs are more active on the surface.

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In our experiments Paris green and metaldehyde were also submitted to test both in the field and laboratory. The formula for the Paris green mixture, which is similar to that recommended for the control of leather-jackets and surface caterpillars, is as follows:—

Paris green	..	..	..	..	1 lb.
Bran	..	..	..	..	25 lb.
Molasses or treacle	..	..	..	..	$\frac{1}{2}$ pt.
Water	..	..	..	..	1 gal.

The bran and Paris green are mixed dry, the molasses or treacle is poured into the water and the latter added to the poisoned bran. The result is a mixture sufficiently friable to be easily broadcast and the dosage advised is 25 lb. per acre costing about 4s. 6d., including the labour of spreading.

Whilst the bran appears to be attractive to slugs it is doubtful if this attraction is increased by the addition of molasses or treacle. Indeed, there is evidence that slugs merely happen upon the poison bran as they wander indiscriminately over the surface of the soil and devour the bran particles which they chance to find. The results obtained by the use of the Paris green mixture in the field were not so satisfactory as those obtained by using metaldehyde. The difference may be explained as due not to a lesser efficacy of the Paris green mixture as to the fact that slugs killed by metaldehyde are readily traceable, since they tend to die on the surface, whereas many of those destroyed by Paris green contrive to pass into crevices of the soil before they succumb, and there escape the eye of the observer.

Metaldehyde is purchased in the form of small tablets under the name of "Meta" and is used as solid fuel. In the control of slugs it is ground to a powder and mixed with bran in the following proportions:—

Meta	..	..	..	..	$\frac{1}{2}$ lb.
Bran	..	..	..	..	25 lb.

The cost of treating an acre with the mixture works out at about 5s., and where 3 or 4 treatments are made at fortnightly intervals, as is recommended, the expenditure of 15s. or £1 thereby entailed is amply justified by the degree of protection obtained. By comparison with poisonous metallic salts, such as Paris green and lead arsenate, metaldehyde has certain advantages. It is non-injurious to plants and does not inhibit nor retard the germination of seeds. By reason of its insolubility it retains its toxic properties for slugs for

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about twelve days after it is spread in the field, and finally it appears to be non-poisonous to human beings, domestic animals and birds. In order to test its effects on the latter, two fowls were fed with meta-bran mixture and grain for four weeks. During this time they consumed 2 lb. of the mixture and yet remained unaffected, although the quantity of "meta" ingested was considerably in excess of what they could have picked up in a treated field in the same time.

Some of the results obtained in fields tests of the "meta"-bran mixture are here tabulated:—

NUMBER OF SLUGS DESTROYED BY 2 PER CENT. META-BRAN MIXTURE
APPLIED TO EXPERIMENTAL PLOTS OF KNOWN AREA

Experiment No.	Dosage of Mixture per Acre	Crop	No. of Slugs Killed per Acre
1	25 lb.	Potato (Kerr's Pink)	12,000
2	25 "	" " "	8,000
3	25 "	" (Golden Wonder)	10,000
4	30 "	Oat Stubble	14,500
5	25 "	Turnip	96,000

The method of testing employed simply consisted in broadcasting the mixture on selected plots of known area, and counts of dead slugs on the surface were made each day for two or three days subsequent to the application of the mixture. In actual practice it was found that only the counts made on the first or second day after treatment were significant. Metaldehyde seems to exert its maximum toxic effect soon after it is applied, and counts made subsequent to the first day are rendered unreliable by the habit of birds feeding on dead slugs exposed on the surface of the ground.

Slugs which have ingested the "meta"-bran mixture are readily traceable by the conspicuous tracks of slime which they leave behind. At the end of the track the affected slug is found either dead or moribund. Since some slugs may succeed in burrowing beneath the surface before dying, the number of dead per acre given in the above table is likely to be more conservative than otherwise. In connexion with Experiment 3, a count of slugs on the surface was made on an adjacent untreated plot where the number per acre was found to be only 600. Whilst the number of dead slugs per acre provides a general idea of the

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efficacy of the "meta"-bran mixture, it must be realized that the number cannot be related to the total slug population, since this cannot be accurately computed.

In point of numbers destroyed, the turnip crop gave a much higher yield than did any of the treated potato fields. The considerable difference is explained by the fact that the turnips were grown in a market garden where excessive manuring encourages an even larger population of slugs than on potato farms.

Time of Application of "Meta"-Bran to Infested Fields.

For the protection of potatoes against slugs, the mixture of "meta" and bran should be first applied in the middle of September, just before the "shaws" wither. Two or three further applications should be made at intervals of 2 weeks, and a treatment of the dunged oat-stubble should likewise be carried out in the autumn.

Since cereal crops are chiefly attacked during the seedling stage, it is essential that the mixture should be applied as soon as signs of damage are noted. So with other crops, the application of treatment will depend on the extent of attack as well as on the season when damage occurs. In any event the mixture is best applied during the late afternoon or evening when the slugs tend to come to the surface.

Other Methods of Applying "Meta." "Meta" may be applied as a powder alone, but the very lightness of the material makes its distribution in the field difficult. Besides this, the high cost of applying undiluted "meta" makes the method impracticable on a large scale. Otherwise "meta" can be mixed with an inert diluent, such as sand. Experiments were made in which "meta" was incorporated with sand in a mixture consisting of one part of the former to 16 parts of the latter by weight. The mixture was applied at the rate of 1½-2 cwts. per acre, the equivalent of 10 lb. of "meta," and worked lightly into the soil. Dead slugs were found on the surface of treated ground four or five days after the treatment was made. It is thus apparent that "meta" may act as a contact as well as a stomach poison, but its effect on slugs by contact appears to be slower than its effect through ingestion. Whilst slugs dusted with undiluted "meta" in the laboratory invariably succeed at first in getting rid of the irritant material in a copious secretion of slime, yet they finally succumb to continued contact with the powder.

IMPLEMENTS AT THE ROYAL SHOW

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At the Centenary Royal Show the implement yard was fully worthy of a great occasion. Judged by the usual comparative statistics of stand frontage or area, there may have been larger exhibitions at some of the Shows of the past; yet one doubts whether so comprehensive a collection of the implements of up-to-date but everyday farming has ever been staged anywhere. Indeed, at Windsor everyday farming was the keynote throughout: there were few spectacular large-scale implements; no commercial motor vehicles; and, except for an occasional grader or bull-dozer, hardly an exhibit that was not genuinely agricultural. On the other hand, exhibits large and small in every corner of the yard illustrated valuable progress towards the ideal of making mechanical power and modern methods equally applicable to all branches of husbandry. In these notes, however, mention can be made only of a few of the more unusual among the hundreds of appliances on view.

Tractors. Any farmer who visited the Show with the idea of choosing a tractor must have found himself faced with an exceedingly difficult task, for, without taking minor differences of wheel type or track width into account, there were something over seventy distinct models to choose from. At least two-thirds of these were small or medium-sized machines, and very prominent among them were those of the new "baby" class—the "four-horse tractors"—that have already been described in this JOURNAL (March, 1939). After inspecting these "babies" alongside their more powerful counterparts, the writer holds more strongly than ever to his original opinion that their proper function is that of the odd-job machine on the large farm rather than the only power unit of the small one. But this opinion implies no criticism of the engineering merits of the new designs: it arises simply from the hard fact that the all-round utility of a tractor depends on good adhesion, and that with a wheeled tractor—whether on steel or pneumatics—adhesion requires weight. Quite apart from these particular machines, there is an obvious tendency to make wheel trac-

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tors more like motor cars. This idea has been steadily gaining ground for some years past in the U.S.A., where it has been helped by a disposition to use higher working speeds, and a rather smaller difference between the prices of different grades of fuel; but not until this year has it been evident here. Whether the tendency is a good one or not only time can show. On the one hand it is realized that automobile engineering in its private and commercial aspects has made immense strides in recent years, and that if agriculture can be made to benefit from this progress so much the better. On the other hand, the everyday work of an agricultural tractor differs so essentially from that of a lorry or car that it may very well be wrong to follow general automobile design too closely. For example, an agricultural tractor in its heavier work is rather in the position of a motor lorry which is condemned to spend all its time climbing steep and slippery gradients, stopping and starting without changing gear: and the machine which is ideal for this purpose is not the one which breaks records at Brooklands. No one can object, however, to the greater power output and better fuel economy that result from rather higher compression ratios; or to a wider range of land speeds coupled with easier gear changing; or to such weight reduction as may result from genuine economy of design. On these and similar points, some of the newer tractor models are well in advance of those of a few years ago. As for the new craze for streamlined exteriors, one can accept it with composure, for while, until tractor speeds are increased at least threefold, it cannot possibly have any practical significance, it may just possibly have some psychological effects on the operator.

A much more important point which is just beginning to receive the attention it deserves is the driver's comfort. Indeed, without going to the extreme of an artificially-heated totally-enclosed cabin complete with wireless set, which one American maker displayed, one can welcome the comfortable double seat of one of the new British machines, and hope that before long it will mark the disappearance, from tractor and implement alike, of the standardized iron perch which generations of non-standardized posteriors have had to endure.

In addition to the general points outlined above, two particular tractor novelties are worthy of mention: a track-laying version of one of the 4-horse machines, and a two-wheeled power unit for direct-coupling to ordinary carts or implements.

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The former is of interest for two reasons: because fruit growers and others have long awaited a narrow gauge tracklayer of full 2-furrow plough capacity; and because on the medium-sized ordinary farm the combination of two small tractors, one wheeled and one tracklaying, may be a useful alternative equipment. The two-wheeled outfit—or mechanical horse as it is called by its maker—is a most intriguing proposition to look at, especially when coupled to a cart; but only a practical trial can decide just how nice an adjustment of implements will be necessary if it is to be effective in other work.

Harvesting and Haymaking Equipment. Harvesting equipment is always prominent at the Royal, while in spite of the tendency in recent years for Shows to become more seasonal in their exhibits, the special occasion this year brought out plenty of haymaking machinery as well. The main harvesting feature was the range of small combines, which included half-a-dozen models with cutting widths from 40 in. to 8 ft. The smallest of them resembles the 5-ft. model of the same make that has already done two seasons' work here, in having a drum equal in width to the cutter-bar and a straight-through passage of straw and grain. Two others among these small machines were slightly unorthodox in appearance: one had a set of light trailing tines attached to the bars of the reel—presumably to prevent the knife from accumulating green-stuff in an undersown crop; while in the other an Archimedian screw arrangement replaced the transverse canvas. Since larger combines have been so universally successful wherever they have been tried in this country, it is only to be anticipated that the introduction of these smaller models will bring a considerable extension in the use of the method. Prospective purchasers should, however, remember that a combine's rate of cutting will certainly not exceed that of a power-binder of equal width, so that with the smallest machines some modification of the normal harvest time-table will be necessary. Among the new implement entries was an attractive-looking grain drier designed mainly to meet the requirements of the user of a small combine, which has still to undergo its first farm trial. This drier uses pneumatic elevators and winnows the grain at the same time. Two other new implement entries were concerned with haymaking. One of them, a neatly-arranged swath-turner and windrower which will handle two 6-ft. swaths, is articulated so as to clear uneven ground, and can be quickly

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folded for transport, was awarded a Silver Medal. The other, a most unusual power mower, was deferred for further tests next year: it returns to the principle of the scythe and, instead of the usual reciprocating knife, uses a rotating band-knife which is continuously resharpened by two emery wheels during operation.

New Implements. Silver medals were also awarded to a deep-tread pneumatic tractor tyre specially designed for work under wet conditions; a dairy sterilizing chest which incorporates a number of improvements resulting from a long process of development and research; and a mechanical beet-harvester. From the very great interest which the latter aroused, one would conclude that the psychological moment for rapid developments in beet harvesting has arrived. Apart from an ingenious tracklaying device for regulating the height of the topping knives and holding the roots steady during the process, the new machine is not very different from some of the other models which have been tried experimentally over the last ten years. With the more acute labour difficulties which exist to-day—and the more definite interest in root-crop mechanization which arises from them—it is to be expected that the accumulated experience of the past will soon bear fruit in the shape of other new machines. Further exhibits which attracted farmers' attention because, in one way or another, they reduce or eliminate what the Americans call "stoop-labour," included two conveyor-type potato harvesters, the latest edition of a well-known mechanical transplanter, and a number of hoeing attachments specially adapted to cross-blocking row-crops. Regarding the transplanter, the most notable new feature is a differential correcting device which enables planting to be done "on the square," and so brings its work more into line with farming practice. In the New Implement class the remaining entries were a vacuum-operated water-pump, a manure distributor, and a type of spiral strake girdle for increasing the adhesion of pneumatic tyres. The manure distributor was of the disc feed type, which past experience has shown to give a very high degree of sowing accuracy, and incorporated several improvements in detail.

Miscellaneous. Among other manure distributor exhibits were a 13-ft. model of the endless chain type with a very handy conversion for transport purposes: a new machine of the conveyor and brush type which is so universally used in

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France; and a farm trailer attachment, which could also be adapted for sowing small seeds. A practical difficulty with attachments of the latter type is that when the trailer carries a full cargo of fertilizer so as to avoid stoppages for refilling, the load is often too much for the tractor to get away with in top gear. In consequence, unless the width of the distributor attachment greatly exceeds that of the trailer, the rate of work is slow in comparison with a multiple-hitch outfit. On the other hand, by making the modern pneumatic-tyred trailer a multi-purpose unit which can reduce capital expenditure in other directions, this design is in line with the latest tendency in farm transport. Several other carefully thought-out trailers were also on view, including one mounted on rubber jointed tracks, of which the most attractive feature was the fact that the platform was no more than a foot above ground level and yet was quite free from projecting parts.

THATCHING IN DORSET

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The Dorset type of thatching differs very little in appearance from that of Norfolk. It is the material used in the thatching that differs. Instead of the wheat reed used in Dorset, thatchers in Norfolk use reed consisting of spear that grows in the marshes. The stalk of this reed is much coarser than that of the wheat reed and the method of thatching is much more expensive. Dorset thatching is done with the stalk of the wheat, i.e., the stalk stripped of the blade sheath.

It is important to stress the difference between thatch and reed, for although our work is called thatching, wheat reed is the most suitable for it. Thatch is a straw which has gone through a threshing machine and been bruised before being cleaned. An entirely different procedure is adopted in the making of reed, as it is essential that the stalk shall be left stiff as well as clean.

In the making of *thatch*, the sheaves are put through the threshing machine to remove the corn, and straw is delivered from the machine loose or tied in bundles, after which it is stacked or ricked. Loose straw is then pulled out by hand. This strips the stalk of superfluous accretions and straightens it. It is then tied in bundles of 10 or 14 lb. ready for use. After bundling, the straw is usually drawn through a thatch comb in handfuls to straighten and to clean it. The thatch comb is made in the form of a stool about 5-6 ft. long with 8 in. iron spikes standing upright about 1½ in. apart.

In the old method of making *reed*, sheaves of corn are placed in a reed press. This is a form of stool about 8 ft. long, having uprights at each end with peg holes in them. After the sheaves are packed in the press, a piece of wood is slipped over these uprights, firmly pressed down and pegged. This holds the sheaves tightly in position, allowing the heads of the corn to be taken by hand and the stalks drawn out. This cleans the blades from the stalk. The heads are cut off, and the stalk, now clean and stiff, is tied in bundles ready for thatching. This method of reed-making by hand is rather expensive owing to the increase in the cost of labour, and a machine reed maker,

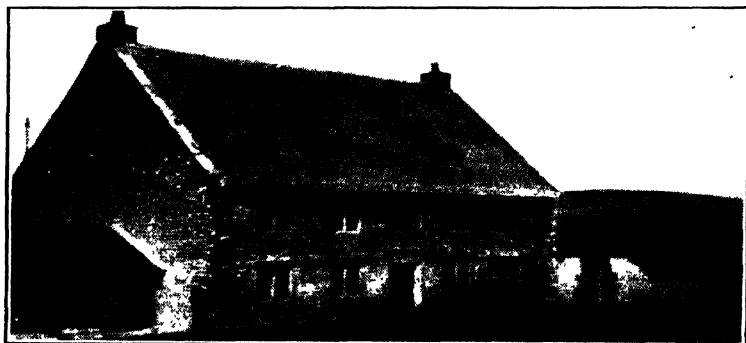
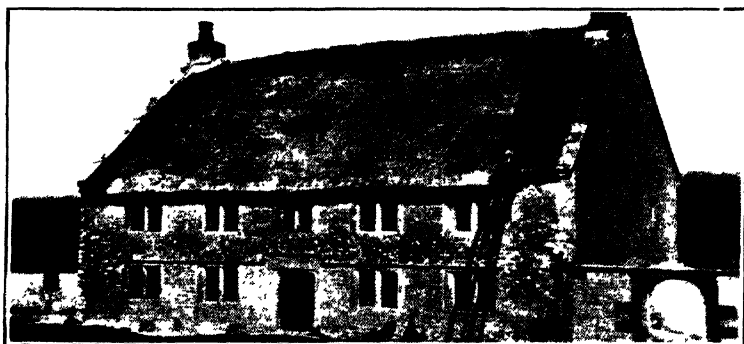


FIG. 1. A thatcher's assistant with bundle of corn reed. Note bundles of twisted spars.



FIG. 2. --Repairing a roof with corn reed.

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FIGS. 3 and 4 — A house re-thatched and altered by piercing roof with dormer windows to give more light to upper rooms

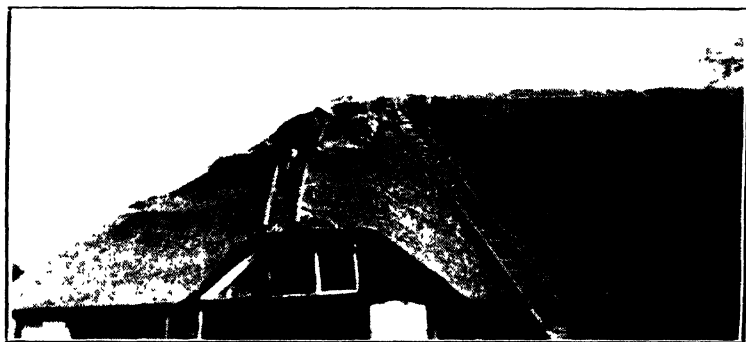


FIG. 5 —The new generation of thatchers re-thatching an old roof The writer's son

THATCHING IN DORSET

fixed to the top of the threshing machine, is now much used. The sheaves of corn are placed in this, and, as the machine operates, the heads of the corn are taken off, the waste taken out, and the stalk, which is not bruised, drops into another machine and is tied up in bundles. This is not quite such a good quality reed as that made by hand but is a good substitute.

Thatch is chiefly used for thatching ricks. Many farmers now use Dutch barns for storing hay or corn, and although this form of storage is simpler, the quality of the hay is not as good as when stacked and thatched. Unless the barn is filled to the roof, the rain drifts underneath and spoils a certain amount of the contents.

In many counties thatch is also widely used for roofs and it is rare to see one done with wheat reed. Thatchers living in these counties could not put on such a roof, as they have never learnt the method, which requires greater skill. When using thatch, it is just laid on the roof, and fixed with spars. It does not go together as tightly as reed; it does not, therefore, have such a neat appearance, and the straw, being bruised, holds the wet, which causes it to wear out quicker. With reed thatching, great care has to be taken to keep it straight, and to make it set tightly together, with the ends pointing outwards. A roof done with reed costs more than a roof of thatch, but it is much cheaper in the long run, as it lasts about three times as long.

There are quite a number of thatched houses in and around the district in which I live and I am kept very busy renewing these roofs. This I do with reed, and a roof well done should last about twenty-five or thirty years. This, of course, depends on the pitch or slope of the roof. A good steep pitch lasts longer than a roof which is not so steep.

When making a new roof that it is intended to thatch, valleys where the water can collect into channels should be avoided, as the thatch wears much better when the water runs evenly over the whole surface. If, however, there must be valleys in the roof, lead gutters should be installed to take the water away quickly.

I have thatched a number of new houses within the last ten years and I find that there is quite a good demand for a house with a thatched roof. There are reasons for the revival of interest in thatch as a covering for roofs. Some people are, undoubtedly, attracted by the quaintness and the picturesqueness of a thatched roof. In days of rush and bustle, such as

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these, a garden and a thatched roof may well stand as the epitome of peace and quietness.

There is, however, an economic factor in this revival of thatching. Thatched roofs are, undoubtedly, cheaper than tiled or slate ones. The rain never drives through under a thatched roof, and a tiled or slate roof must have a board or felt undercovering to be absolutely watertight, which increases the cost considerably.

Further, the more even house temperature obtained with a thatched roof may have something to do with it. Thatch certainly makes the most comfortable roof to live under, as in the summer it keeps the house cool and in the winter the cold cannot penetrate as through tile or slate roofs. I can well remember when I was a boy, moving from a thatched house to a house roofed with slates. The weather was very warm at the time and we found the bedrooms very different from the cool rooms under the thatched roof.

The trade of thatcher has been carried on by my ancestors for several generations. When my father started to learn thatching from my grandfather, someone said to him, "If I were you I wouldn't let my boy learn thatching, as by the time he knows the way to do the job, all thatching will have died out." That was nearly seventy years ago. I have a son who has just learnt the thatching, but I have not had that remark made to me.

Thatching a New House. The roof is timbered in much the same way as that to be roofed with tile or slate, the only difference being that the rafters are kept about 3 in. inside the outer edge of the wall. This is very important, as it gives the reed a slight turn outwards to make it set together closer. The reed is first damped to make it easier to handle and also to make it go together tighter on the roof. We then tie some of the reed into small bundles, or wads as we call them, which are tied to the bottom of the roof to form the eaves and to get the drip over the walls. Each bundle is tied on separately, tarred twine or cord being used to ensure a lasting foundation. The reed is then laid on loosely in layers or settings of about 1 ft. thick, being driven into the shape of the roof by the thatcher's beetle, which is made from a piece of elm wood, 10½ in. long, 8½ in. wide and 1½ in. thick, and with grooves cut in it to catch the ends of the reed. Across this layer of reed is placed a tying rod, made of hazel or withy about the

THATCHING IN DORSET

size of a man's walking stick. An iron needle about 2 ft. long, similar to a sewing needle, is threaded with tarred twine and pushed down through the reed, carried under the rafter and up and over the tying rod. The twine is then pulled very tightly and tied. This process is continued up the roof to the ridge. The closer the reed is packed and the tighter it is tied, the longer it will last.

Re-Thatching. When re-thatching old houses we usually pull out all the thatch at the eaves and tie in new. Then we leave a certain amount of old thatch and fix the new on the top of it. The procedure is the same as described for a new roof, but spars are used to hold the reed in position. These are kept underneath except where the finish comes at the ridge, where a decorative design gives the whole a nice appearance. The reed is finally trimmed all over with a thatcher's hook specially made for the work.

I should, perhaps, explain what a spar is and how it is made. We use hazel or withy (the colloquial term for willow) wood in making these as both will split easily and twist readily. Sticks vary from $\frac{1}{2}$ in. to 2 in. in diameter, making 2-8 spars each according to their size. For house thatching, spars 2 ft. 6 in. long are used. They are twisted in the middle to the shape of a lady's hairpin. We make these in very cold, wet or windy weather when we cannot work on the roofs, but I buy most of my spars from men who do this for a livelihood.

There seems to be a scarcity of really skilled thatchers. In consequence, there are a number of men handling the job who do not understand the work. In my opinion, such people spoil the name of thatching, as their work is not good to look upon, nor does it last any length of time. Thus re-thatching proves often needful and this makes it very expensive. In the end it proves cheaper to have a roof thatched by a skilled thatcher.

There is still a great demand for old cottages and farm houses with thatched roofs and stone mullioned windows. In many instances these are being modernized as regards sanitation, and dormer windows are sometimes put in to give increased light, but the old-world appearance of the exterior is maintained.

In the building illustrated in Figs. 3 and 4, there were two rooms at the top of the house with scarcely any light, so we put two new windows in the roof, which gave it a better

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appearance and also improved the rooms. This house is, I think, over 300 years old.

Thatch and Fire Danger. There are a few people who think that thatched roofs are dangerous as regards fire, but I have found that it is hardly ever the roof that actually catches fire first. The fire usually starts in a smouldering beam or by some other means within the house, and what roof will not burn once a fire has a hold? If the chimneys are well constructed, there is little likelihood of fire breaking out. This is proved by the numbers of thatched houses that have stood for centuries. I have often found in old chimneys quite large holes underneath the thatch, through which smoke has been coming for a number of years, and nothing in the nature of a fire has taken place.

FEEDING STANDARDS FOR FARM ANIMALS: V. THE MINERAL REQUIREMENTS

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Thirteen mineral elements are now recognized as essential constituents of the body. These are calcium, phosphorus, sodium, potassium, chlorine, magnesium, iron, sulphur, iodine, copper, manganese, zinc, and cobalt. These mineral elements fulfil three main functions. *First*, as constituents of the bones and teeth they give rigidity and strength to the skeletal structures. *Second*, they regulate the neutrality of the body fluids, a necessary condition for the proper functioning of the body cells. *Third*, they form essential constituents of certain organic compounds which occur in the soft tissues, the secretions and the circulating blood. In the skeletal structures, calcium and phosphorus predominate, while sodium and chlorine form the chief mineral constituents of the body fluids. As regards the soft tissues, potassium occurs largely in muscular tissues; sulphur and phosphorus are essential constituents of certain cell proteins; iron forms the basis of the haemoglobin of the blood; while iodine is necessary for the proper functioning of the thyroid gland. Magnesium is an essential constituent of both bone and soft tissues. The remaining elements noted above (i.e., copper, manganese, zinc and cobalt) are only required in minute amounts and are usually referred to as "trace" elements.

Mineral Requirements. It is obvious that all the above essential elements must be supplied in the food during the period of growth. It is equally obvious, however, that the proportions of each element required will vary with the stage of development of the animal. Thus, during early growth, when skeletal development is most rapid, there will be a maximum demand for calcium and phosphorus which will be required for bone formation. As the animal approaches maturity the demand for these two elements will be reduced, and the demand for those elements associated with the soft tissues will tend to predominate. During fattening, the mineral requirement will be minimal. It is clear, therefore, that not

FEEDING STANDARDS FOR FARM ANIMALS

only will the total requirements of mineral elements vary according to the stage of growth, but the proportions of the various elements will also vary according to the relative rates of deposition of bone and soft tissues. Moreover, experiments show that the mineral requirements also vary with the general growth rate: thus young pigs, which are comparatively fast growing animals, are found to be definitely more susceptible to mineral deficiencies than calves, which grow at a slower rate.

It might be assumed that similar difficulties would not be encountered in determining the mineral requirements for lactation, since the composition of milk is relatively constant. Here, however, the investigator is faced with a new difficulty, since in the absence of adequate minerals in the ration the lactating animal is capable of calling on its comparatively large mineral reserves in order to maintain its milk yield unimpaired. Numerous workers have shown, in fact, that high-yielding cows at the peak of their lactations are invariably in negative calcium and phosphorus balance, i.e., that they are losing more of these elements in their milk than they can assimilate from the food. But, as will be seen later, the cow has such a well developed capacity for storing a reserve of both these elements in the bony tissues that she can readily tide over any temporary heavy demand, and can subsequently replenish her reserves during the next dry period. The requirements for these two elements cannot, therefore, be ascertained simply by determining the effect of different levels of feeding on the milk yield. Moreover, while it is true that the mineral composition of milk is relatively constant, the content of certain elements varies markedly with the composition of the ration. Thus it has been shown that the iodine content of the milk depends largely on the level of iodine in the food, while a reduction of the iodine content of the ration does not necessarily or immediately lead to a reduction in the total milk yield. As regards the maintenance requirement, a similar elasticity is shown by the body in its ability to vary the excretion of minerals according to the level of feeding: with an excessive mineral supply the excretion will immediately increase; when mineral deficient rations are fed, however, excretion will be reduced to very small proportions and any loss of minerals under such circumstances may be looked upon as accidental rather than as a constant function of the body.

This brief discussion will be sufficient to indicate some of

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the major difficulties which are involved in any attempt to arrive at an exact estimate of the mineral requirements for either maintenance, growth or lactation.

Efficiency of Utilization. The problems involved in determining the efficiency of utilization of the mineral constituents of a ration are no less complex. In the first place it must be emphasized that the mineral contents of feeding stuffs are themselves subject to large variations. This applies particularly to pasture grasses, and it is significant in this connexion that the recognition of the importance of mineral elements in the nutrition of farm live stock was largely based on the study of various deficiency diseases which are liable to occur in animals kept under range conditions on mineral deficient soils. But it is now equally well recognized that differences in the application of fertilizers, in the climatic conditions and (in tropical countries) in the frequency of irrigation may also effect marked changes in the mineral composition of feeding stuffs and fodders. Moreover, even where the composition of a feeding stuff is known, the availability of its mineral constituents will to some extent depend on the form in which these are present in the plant tissues. This applies particularly to the phosphorus which, if present as "phytin" (as in cereal seeds and their products), is less readily assimilated than in other forms. In the same way the presence of oxalic acid in the leaves of certain calcium-rich plants has been found to interfere with the assimilation of this element.

The effective assimilation of calcium and phosphorus is also partly dependent on the preservation of a proper balance between these two elements in the ration, while the presence of excessive quantities of magnesium has in some instances been found to affect adversely the retention of calcium in the body. The adverse effect of fluorine in association with calcium and phosphorus (as in rock phosphate) may also be noted.

On the other hand, it is well known that the assimilation and utilization of these two elements is greatly enhanced by the presence of adequate supplies of vitamin D in the diet, a condition which may be assured by the inclusion in the ration either of well cured hay or of specific sources of this vitamin, such as cod- and certain other fish-liver oils. Assimilation is also enhanced by exposure of the animal to bright sunlight, and recently it has been found that the feeding of substances which produce a high acidity in the digestive tract (such as

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lactose or milk sugar) has the same favourable effect. Any excessive laxativeness in a ration is, however, liable to interfere with the assimilation of these and possibly of other mineral elements.

These few notes show clearly that the investigator is not only faced with considerable technical difficulties in arriving at the theoretical mineral requirements of live stock, but that equally difficult problems are involved in any attempt to formulate practical rationing standards to meet such requirements. It is clear, therefore, that in order to arrive at satisfactory mineral feeding standards for farm animals it is necessary to under-estimate rather than to over-estimate the percentage utilization of the mineral constituents of the ration. It is usual to assume that not more than 33-50 per cent. of the mineral constituents are capable of utilization, and such standards as have so far been formulated provide, therefore, for the inclusion in the rations of from two to three times the estimated theoretical requirement. This provides a margin which is adequate to safeguard stock against any risk of serious mineral deficiencies.

Mineral Supplements. The breeder can, moreover, afford to be over-generous in meeting the mineral requirements of his stock since suitable mineral supplements can be purchased extremely cheaply. In feeding mineral supplements two points must, however, be kept clearly in mind. *In the first place, the addition of such supplements cannot stimulate production above the normal level.* If the ration is already adequate in regard to its content of minerals, the addition of a supplementary mineral mixture will therefore clearly be valueless. In the second place, and as a logical consequence of this fact, *the effectiveness of any mineral supplement will depend solely on the extent to which it makes good some deficiency in the ration.* Minerals should, therefore, only be fed in order to remedy a known deficiency or at most to provide a safety margin where the exact requirements cannot be assessed. This raises the crucial question as to the nature of the mineral deficiencies which are most likely to be encountered in general feeding practice in this country.

It is sometimes assumed that the most common form of mineral deficiency is a lack of calcium and phosphorus, and that these two elements should form the bulk of any mineral supplement. As regards phosphorus, it is extremely unlikely

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that any well balanced ration will be phosphorus deficient. It is true that most roughages are relatively low in phosphorus, but the phosphorus content of cereals is remarkably high, and with exceptionally productive animals (such as high-yielding cows) the concentrate required to balance the protein of the ration will usually be rich in phosphorus. The supply of calcium will also be adequate when animals are grazing on good pastures. With indoor feeding, however, highly productive stock, particularly if fed on rations containing a large proportion of cereals, are liable to suffer from a calcium deficiency. *The rations of such stock should invariably be supplemented by the addition of a suitable calcium salt such as finely ground chalk.*

Reference has been made earlier in this article to the large stores of calcium and phosphorus which are present in the bony tissues of adult stock and which can be mobilised for milk production if the ration is mineral deficient. Unfortunately, there are no such reserves of sodium and chlorine in the body. Calculations show, for example, that a 1,000-lb. cow contains roughly 40 lb. of calcium phosphate but only about 3-4 lb. of sodium chloride. In a 1,000-gal. lactation such an animal will secrete about 30 lb. of the two former elements and about 20 lb. of the two latter. It is clear that, whereas a deficiency of calcium and phosphorus can be met temporarily from the body reserves, there is no similar means by which a deficiency of sodium chloride can be made good. Moreover most foods are relatively deficient in both sodium and chlorine. A random examination of a typical series of analyses of feeding stuffs (including concentrates, cereals and fodder crops) shows that the percentage of sodium and chlorine is usually barely half that of calcium and only a fraction of that of either phosphorus or potassium. *There is indeed no doubt that a shortage of common salt is a far more frequent cause of mineral deficiency among farm live stock than a shortage of any other mineral.* This fact is now fairly generally recognized, and it is usual on well managed farms either to provide the milking stock with salt licks or to feed rations to which an appropriate quantity of salt has been added.

There is a somewhat widespread belief that a deficiency of iodine is a common cause of ill-health and poor productivity among stock, and that a supplement of potassium iodide will result in improved growth and milk production. There is at present no clear evidence which supports this contention.

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Among the human population, iodine deficiencies are confined to definite goitrous areas, and it appears that the same is in general true of the livestock population. Experimental attempts to increase either growth or milk secretion in animals which are receiving well balanced rations, by administering potassium iodide, have usually proved negative, and indicate that under ordinary conditions of management iodine deficiencies are infrequent. It may incidentally be noted that the feeding of abnormal quantities of iodine to milking cows has been proposed on the grounds that this results in the secretion of 'iodized' milk, and that the latter might be of special value in human nutrition. Apart from the fact that the administration of iodine to human subjects requires expert medical supervision, the feeding of excessive amounts of iodine may actually result in harmful effects to stock, while in any event the method would be extremely wasteful, since only a small proportion of the ingested iodine is secreted in the milk. *The breeder should therefore accept statements regarding the beneficial effect of iodine administration with considerable reserve.*

As regards the remaining elements, it may be stated that the possibility of a potassium deficiency is extremely remote. Magnesium deficiencies are seldom encountered among stock fed on normally balanced rations. Deficiencies of iron and copper only occur in growing animals which subsist for long periods on a milk diet, and whose reserves of these two elements are inadequate to carry them to the weaning stage. This is true of the suckling pig, and steps should be taken to remedy any such deficiency by providing the young with adequate quantities of a commercial iron salt. As regards the remaining "trace" elements (i.e., manganese, zinc and cobalt) deficiency symptoms have been obtained only by special feeding or (as regards cobalt) in stock grazing on mineral deficient pastures. The quantities of these elements present in the common feeding stuffs can invariably be relied upon to provide adequate supplies for the maintenance of satisfactory health in farm stock.

Finally, it will not be out of place to re-emphasize the fact that under British farming conditions the only mineral supplements which are normally required are calcium, phosphorus and common salt. As H. H. Mitchell has recently stated, the practice of including in commercial mineral mixtures many more components than are necessary for the proper supple-

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menting of farm rations generally increases the cost of the mixture without improving its effectiveness as a supplement. Mitchell suggests (and it is a suggestion which the breeder might well adopt) that those who are sceptical of this statement should try out for themselves the relative values of a complex commercial mineral mixture and of a simple home-produced mixture such as that laid down in *Rations for Live Stock*. In any such comparative test the breeder should not be unduly impressed if his stock consume more of the commercial mixture, since such mixtures usually contain condiments which induce animals to consume them whether or not the minerals are actually needed to supplement the ration. The quantity of a mineral mixture consumed by stock is never a sure criterion of its value; *the real test is whether the inclusion of the mixture results in more rapid growth, in better health and in increased productivity.*

WIREWORMS AND THE BREAKING UP OF GRASS LAND

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One of the deterrents to the breaking up of grass land in many parts of Britain is the anticipation of serious losses from the attacks of insects whose normal home is in the old turfy layer. Wireworms, leatherjackets, weevil grubs, chafer larvae or white grubs, and the caterpillars of swift moths live on the underground portions of grasses and other grassland plants and on the vegetable matter that accumulates in the surface soil. While grass land is undisturbed these insects are only of occasional local importance, since losses to the plant population are obscured by the outward growth of other plants and the establishment of new plants from seed. The ploughing of grass land changes completely the environment of these insects and greatly reduces their food supply, so that they are forced to feed on crop plants in order to complete their development.

Wireworms are undoubtedly the most important of the grassland insects. Leatherjackets, swift moth caterpillars and weevil grubs reach maturity the first season after ploughing and cause no further injury. Chafer larvae or white grubs, though widely distributed, are usually only injurious in poor grass land at the edges of woodland. But wireworms are widespread in grass land throughout Britain, especially on light and medium soils, and the population of old grass land may vary from 500,000 to well over a million wireworms per acre. Injury from these insects continues for up to five years after ploughing and generally reaches its peak during the second and third years.

Life History of Wireworms. Wireworms are the grubs of click beetles, and the most common and widespread species of click beetle appears to be *Agriotes obscurus* L., a dark brown or reddish brown beetle rather less than $\frac{1}{2}$ in. long. The beetles are present from late March or early April until June, and may be found under clods of soil, in tufts of grass and other low-growing vegetation, and in heaps of hedge brushings and plant refuse. They are rather sluggish and do not

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readily take flight. During the spring they feed on the leaves of cereal crops and grasses without causing appreciable injury, and during this feeding period the eggs mature in the bodies of the females. Eggs are deposited in the soil to a depth of half an inch below the surface, usually in June. The beetles prefer damp soil for egg-laying. There is some evidence that in addition to rough grass land they select soil under wheat or oats or under first- and second-year grass mixtures when these are available, probably because the humidity is more suitable under these crops than under root crops or market-garden crops, where there is a considerable area of exposed soil at this time of the year. The eggs are translucent white, spherical and about 1/50 in. in diameter, and they are deposited singly or in loosely adhering clusters. Hatching takes place from a month to six weeks after egg-laying, usually during July and early August.

The newly hatched wireworms descend into the soil, where they feed on humus, decaying vegetation and manure. By the end of their second winter they are 2/5 in. long and have well developed biting jaws capable of tearing sound plant tissue. They have the characteristic wireworm appearance and feed at the roots of grasses and farm and garden crops. The common wireworm, *Agriotes obscurus* L., feeds for 4-5 years after hatching. Moulting usually takes place in spring and autumn, and at maturity the wireworm attains a length of about 1 in.

After the final feeding period the wireworms tunnel into well packed earth to a depth of from 1 to 10 in. from the surface. Pupation takes place in soil cells. The pupa is soft and white and enclosed in a delicate translucent membrane. After about a month the beetles mature, but unless they are disturbed they remain in the soil cells throughout the winter. Those beetles that have been disturbed by cultivation take shelter in dense vegetation, in hedge bottoms and about the bases of stacks.

Effect of Ploughing and Cultivation on Wireworms. The ploughing of grass land has certain well marked effects on the wireworm population. The breaking up of turf restricts their food supply and exposes them to greater fluctuations of temperature and humidity. This leads to more pronounced wireworm movements in the soil and crops are attacked during the search for food and for a suitable environment.

The normal wireworm population consists of wireworms of all ages distributed irregularly over the field. Some informa-

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tion on the nature and density of the wireworm population may be obtained by sampling, but a considerable number of samples must be examined before any reliable estimate can be formed. A suitable sample is an 8-in. square taken to a depth of at least 8 in. Where even distribution is assumed and the average number of wireworms per sample is 3, a population of about 300,000 wireworms per acre is indicated, a number sufficient to cause serious injury to crops. If small wireworms are abundant in the samples, wireworm injury may be expected to continue for 4 years. Under any circumstances injury should be anticipated for three years after grass land is ploughed.

The operations of ploughing and subsequent tillage exposes wireworms to birds and other natural enemies, and, when possible, cultivating and harrowing should be done at those seasons when the wireworms are plentiful at the surface of the soil. Bare fallow is expensive to maintain, as the land needs to be cultivated at least once a month to destroy the successive crops of weeds, but it disturbs the wireworms and exposes them to the persistent attacks of birds. Rolling and cultivation tend to keep the surface soil unsuitable for wireworms and enable cereals and grass crops to become well established before wireworm attack begins.

As long as land is under arable cultivation, though reinfestation by wireworms may take place, the population level is unlikely to reach that met with in grass land. Little shelter is available for click beetles, and conditions at the soil surface are not always favourable for egg-laying. Each year some of the wireworms reach maturity and after the fourth year wireworm injury to crops should be negligible.

For the first year after the ploughing of grass land wireworm injury may not be serious. As long as there is undecayed turfy matter in the soil the wireworms prefer it as food, and in normal seasons it is only after the turf has disintegrated that they attack crop plants. Such factors as soil moisture and soil temperature are directly associated with cultivation and with the amounts of organic matter in the soil, and help to determine the extent of wireworm activity.

The peak of injury usually occurs the second season after ploughing and crops susceptible to direct loss should therefore be avoided in the second year. During the third and fourth seasons wireworm injury decreases since each year some wireworms reach maturity and leave the soil.

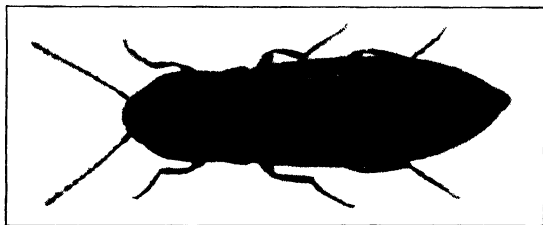


FIG. 1 The Click Beetle, which emerges from the chrysalis during September and may hibernatic in the soil in hedge bottoms or in stacks and refuse. The actual beetle is about $\frac{1}{2}$ in. long.



FIG. 2 The eggs of the Click Beetle laid in the soil under rough grass and coarse herbage. The actual eggs are about $\frac{1}{3}$ in. in diameter.



FIG. 3 The chrysalis formed by the wireworm in compact soil during July.

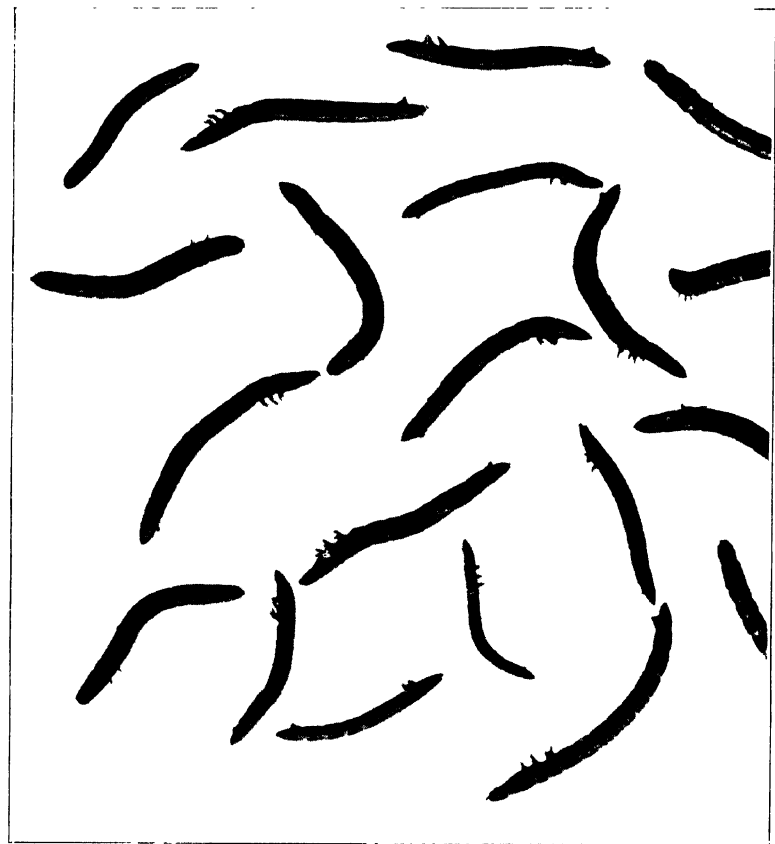


FIG 4 —Wireworms, such as are present in vast numbers in newly-ploughed grass-land. Actual length of tully-grown wireworm is about 1 in

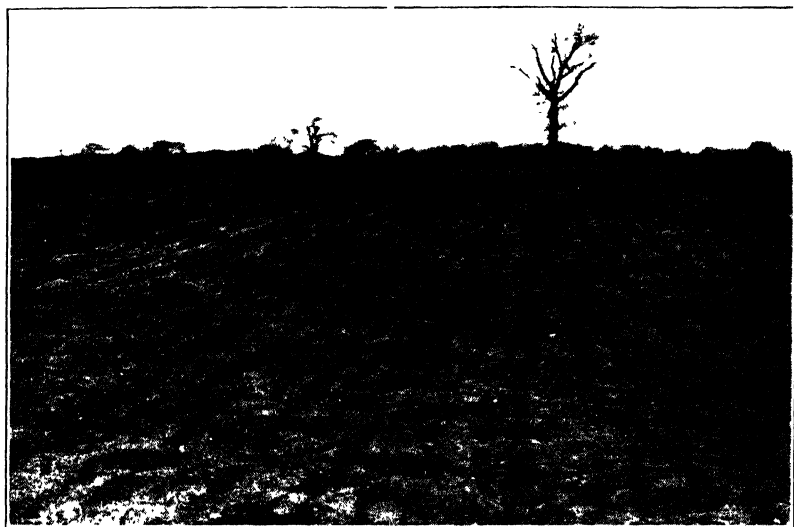


FIG. 5. Young wheat badly thinned by wireworm attack.



FIG. 6. Young wheat may be attacked in the seedling stage, and both the seed grains and the young shoots may be destroyed. The good tillering power allows the plants which escape attack to fill up and form a good plant.

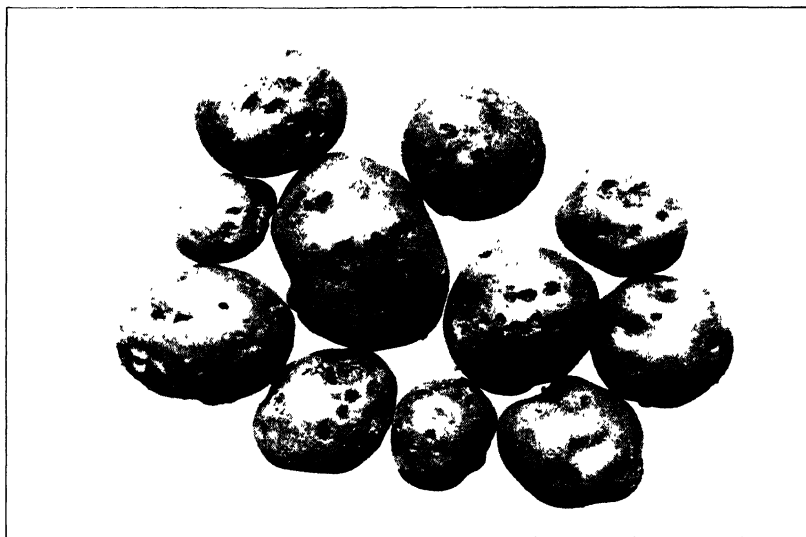


FIG. 7 Potatoes are very subject to wireworm injury and suffer especially during September, October and November



FIG. 8 Injury to potatoes by wireworms may continue in the clamps and the wastage on the clamp site is often serious

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Habits of Wireworms in Relation to Ploughing Grass Land. The study of the life history and habits of wireworms indicates that carefully planned ploughing and tillage operations may assist in reducing the wireworm population. Wireworm activity in the soil varies greatly with the time of the year and the nature of the season. The insects are present in the surface soil in greatest numbers in spring and again in autumn, during the periods mid-March to June and mid-September to early November. At these seasons they feed voraciously and wireworm injury to crops is most marked. At other times of the year the insects penetrate to some depth in the soil and injury to crops is less apparent. It is obvious that the choice of either the spring or autumn feeding period for the ploughing of grass land exposes the greatest numbers of wireworms to the attacks of insectivorous birds and renders conditions of food and humidity less favourable for the wireworms.

Click beetles find shelter about tufts of grass and other herbage during the spring feeding period before egg-laying begins, and any reduction of this shelter, either by ploughing or close grazing, tends to be reflected in the subsequent wireworm population. Tillage during June and July when eggs are in the surface soil is likely to expose them to sun and drought, and consequently reduces the hatch of young wireworms. Newly hatched wireworms and chrysalids are also highly susceptible to disturbance. In July and August young wireworms leave the eggs and endeavour to penetrate to some depth in the soil in search of suitable food and environmental conditions; tillage operations at this time expose them to unfavourable temperatures and humidities and greatly increase the mortality. At this time of the year mature wireworms cease to feed and, after constructing cells in the soil, change into chrysalids. Any disturbance of the soil is likely to break the soil cells and expose numbers of inactive chrysalids to birds and predatory animals and insects.

These considerations support the general recommendation that permanent grass land should be broken as soon as possible after mid-summer or directly after the harvesting of the hay crop. Whenever possible, the land should be heavily stocked during May and June for 2 or 3 years prior to ploughing, so as to reduce the covering of grass and in this way limit the shelter available for click beetles during the egg-laying periods. The land should be ploughed as deeply as possible so as to turn in the turf to a depth of 8 in. or more. The land should later

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be worked whenever time and labour can be spared until about the end of September. When it is necessary to break up land after a hay crop the aftermath should be sacrificed, and ploughing should follow immediately after the first cut of hay. This should allow for the thorough working of the land during the late summer and early autumn and secure some of the advantages associated with fallowing.

For shallow soils, summer fallowing and September seeding with a suitable seeds mixture on a firm seedbed is probably the best procedure. In such circumstances where a nurse crop is desired, wheat sown in September, constant rolling and harrowing in spring and seeding down is satisfactory.

Observations on Wireworm Injury During Two Seasons after Ploughing of Grass Land. Recently some observations on the extent of wireworm injury during the first two years after the ploughing of grass land were made possible through the kindness of Mr. W. B. Mercer, Principal of the Cheshire School of Agriculture. An old pasture at Reaseheath was ploughed in the autumn of 1936, and sampling indicated that the wireworm population was approximately 300,000 per acre. For observation and experiment the field was divided into strips: A, B, C and D, Strips A and B having a denser wireworm population than C and D. Alternate strips were cropped with winter wheat and potatoes in 1937, and in 1938 the cropping plan was reversed. In this way information was obtained on the extent of wireworm injury to both wheat and potatoes when taken as first- and as second-year crops on newly ploughed grass land. The amount of injury is shown in the following table:—

	Strip A	Strip B	Strip C	Strip D
Crop 1937	wheat	potatoes	wheat	potatoes
Wireworm Injury (percentage)	less than 1	15	less than 1	8
Crop 1938	potatoes	wheat	potatoes	wheat
Wireworm Injury (percentage)	33	10.6	18	8.6

The figures given in the table verified previous observations that wireworm injury was greater during the second year after ploughing than it was during the first. During the first season, wheat seedlings made good progress and an even plant was

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established without any noticeable injury. Careful examination showed that less than 1 per cent. of the tillers were attacked; few wireworms were found in the plant rows, but numbers were feeding in the turf which had been buried to a depth of 8 or more inches. During the second season, wireworm injury to wheat was apparent during March and April, 10.6 per cent. of the tillers being attacked on Strip B, and 8.6 per cent. of the tillers being attacked on Strip D. Although these losses were much greater than those occurring during the first season, the crop filled up well and produced a normal yield.

During both seasons the potato crops were more seriously injured than the wheat crops. Random samples of tubers were drawn from five areas in each strip and the numbers of penetrating holes recorded. In 1937, the wireworms fed mainly on the decaying turf, but in the middle of August, attack on the new tubers began and continued until the crop was lifted. An average of 11.5 per cent. of the tubers were seriously injured in 1937, and in 1938 the injury increased to 25.5 per cent. It is interesting to note that the chief injury to the potato crops occurred at a time when wireworm injury to the wheat crop could no longer take place. The autumn migration of wireworms to the surface soil occurs in wheat fields as well as potato fields, but in potato fields the crop is present and may be seriously affected, while in wheat fields only the stubble remains.

Suggestions for Cropping Newly Ploughed Grass Land.

The primary aim of the Government contribution to farmers for ploughing grass land is to improve tracts of poor grass land so that it may be used for the production of arable crops in times of national emergency. Should no national emergency arise, the subsequent cropping of the newly ploughed grass land would be decided by each farmer himself.

The subsequent cropping should be borne in mind when the time and method of breaking up are determined, and experimental work is still necessary to ascertain how the method of breaking up grass land affects the wireworm population. In many parts of the country, the newly ploughed land will be immediately re-seeded with a grass mixture, and for this a good firm seedbed is necessary. Ploughing should be deep enough to bury the turf in order to prevent the old grasses growing through and competing with the newly sown seeds.

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The ground should be rolled to secure a suitable firmness and be lightly harrowed. To ensure a good "take" of seeds, suitable liming and manuring should be carried out before seeding. With this crop little evidence of wireworm injury is to be expected. During the critical period when the seeds are becoming established, the wireworms feed on the decaying turf. By the time that is exhausted the normal grassland environment has again developed and the feeding of wireworms leaves little mark in the crop.

Where autumn-sown cereals are used as nurse crops for seeds, the turf should be buried at ploughing as deeply as the soil will permit and a furrow press used if available. The ground should be disc-harrowed and rolled and the seed sown as early as possible. The effects of wireworms on the cereal crop and the seeds are probably negligible, since the wireworms feed on the buried turf for the first season and in subsequent seasons the feeding of wireworms produces little apparent injury to grass land.

On some farms the newly ploughed grass land will pass into arable cultivation, and problems similar to those associated with grass-arable farming will be encountered. When potatoes or roots are to be grown as a first crop, a satisfactory method of breaking up the grass land is to plough so as to bury the turf deeply in the autumn or early winter and to work the surface frequently to accumulate sufficient soil for ridging the crop. The buried turf provides food for the wireworms until the summer or early autumn of the first season, but as this becomes exhausted the wireworms are attracted to the swelling potato tubers. To keep losses from wireworm attack at a minimum it is essential to lift potatoes early in the season before the autumn migration to the crop is well advanced, so the selection of a suitable mid-season variety is important.

For root crops with penetrating tap roots, such as sugar-beet, mangolds and swedes, shallow ploughing in the early autumn, followed by disking to cut up the turf, and deep ploughing in the spring should produce favourable conditions for the growth of the crops. Wireworm injury may develop in these crops during the autumn of the first season after ploughing, but little effective loss other than slight loss of weight is experienced.

In districts where grass-arable farming is the general practice it is usual to take a cereal crop after the ley and to take potatoes or roots the second year. Where the first crop is

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wheat, ploughing up the ley before the corn harvest is very desirable, for unless this is done several injurious species of insects pass directly from the ley to the young wheat and cause serious loss. Observations on the extent of injury by wireworms to potato and cereal crops during the first two seasons after ley suggest that some rearrangement of the cropping system would help to reduce the heavy losses. Attack on potatoes directly affects the market value of the crop. It seems advisable, therefore, that this crop be taken during the first season, when little wireworm injury is to be expected. The possibility of substituting mid-season varieties for main crop potatoes is worth considering for land known to have a high wireworm population, since this would permit the potatoes to be lifted before the autumn migration of the wireworms to the surface was complete. Although such mid-season crops might fetch less in the market than popular main crop varieties, their comparative freedom from wireworm injury might make them of greater value than more heavily attacked main crop potatoes. Where main crop potatoes are grown, the tops might be sprayed with sulphuric acid in September in order to hasten ripening and allow lifting to take place early in the season.

During the second year after grass, severe injury by wireworms may be expected, since only a small proportion of the insects have reached maturity and left the soil, and the turf which is their normal food is almost completely disintegrated. Although cereal crops are highly susceptible to attack they are especially suited for cultivation during this most difficult season. In a cereal crop there are 500,000 to 800,000 plants per acre, each with a potential capacity for developing a number of tillers, and gaps caused by the destruction of some plants by wireworms tend to be filled by the outward growth of the adjoining plants. Since sprouting grain is exceedingly attractive to wireworms some advantage may be gained from double sowing, half of the seed being sown the way of the ploughing and the remainder across the ploughing, and rather more than the usual quantity of seed should be allowed. The plants should be encouraged to make rapid growth by the use of a complete fertilizer in the seedbed, and the fertilizer may be sown with the seed. In seasons of high wireworm activity bare patches may appear in the crop in the early spring. Growth and tillering should be stimulated by dressings of quick-acting nitrogenous manures in the early spring,

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and bare patches that persist may be sown with spring wheat or oats. By such methods it is possible to produce a cereal crop on wireworm-infested land during the critical second year after grass. Even where the yield is seriously reduced, the market value of the crop is not impaired, since the injury is concentrated at the crowns and roots of the plant and the quality of the grain is not affected. When selecting varieties of cereals for wireworm-infested land, those with a high tillering power should be preferred since they more readily grow away from wireworm attack.

During the third year after breaking up grass land wireworm injury may still be serious, for although the wireworm population is reduced little undecayed organic matter remains in the soil and the insects are dependent on crop plants for food. The maintenance of a high proportion of organic matter in the soil during the second and third years after ploughing should be of value in helping to protect the crops. Heavy dressings of farmyard manure or the adoption of a system of green manuring with mustard, vetches or lupins might be used as a source of organic matter. Suitable crops for the third year after grass appear to be peas or beans and swedes, cabbage rape or kale, since these do not seem to be particularly subject to wireworm attack.

WINTER FATTENING OF CATTLE

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The winter fattening of cattle is usually adopted of necessity rather than of choice, and it is not difficult to define the circumstances which make it necessary.

The arable farmer who follows the Norfolk four-course rotation, or one of the common modifications of that rotation, generally has abundant supplies of straw as a by-product of his corn growing, and also has some kind of roots grown as a cleaning crop. It is only in special circumstances that either of these products can be sold in any considerable quantity, and the winter feeding of cattle provides an outlet and gives a return for them, which is at least better than nothing. Moreover, the manure produced by the cattle is always valued, indeed, is often regarded as absolutely essential for the maintenance of the fertility of the soil.

The financial aspect of winter fattening differs fundamentally from that of summer fattening on grass. The grazier expects to make a clear profit on the cattle, and, in fact, may have no other source of revenue. His expenditure on labour and feeding stuffs is low and he would be very well content if he could sell his cattle for as much per cwt. as they cost. In winter fattening, the expenses on labour and feeding stuffs are so heavy that the bullocks must be sold at a considerably higher price per cwt. than they cost if the results are not to be financially disastrous. The arable farmer cannot be content with a satisfactory price for the mere increase in weight put on during the fattening period. He must also have an increase in value of the original weight. As a rule this is possible. Cattle are relatively cheap in the autumn and dear in the spring, so that an increase of at least seven or eight shillings per cwt. is commonly secured. Even so, a profit and loss account of the winter fattening of cattle is at first sight far from cheering.

As an example, the returns calculated in a Yorkshire investigation and summarized by Mr. W. H. Long in the January number of the *Farm Economist* may be quoted. They refer to 461 cattle fattened in 14 lots during the winter of 1937-38. The

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gross margin on the cattle was £7 6s. 5*d.* each, which, at first sight, appears to be not a bad result, but expenses, including £7 8s. 11*d.* per head for food, convert this margin to a gross loss of £1 6s. 2*d.*, and it should be noted that nothing is allowed in the accounts for overhead costs or interest on capital.

It is possible, however, to view the results in a different way; and whether they will be regarded as unsatisfactory or not depends on circumstances. First, it is to be noted that the charges against the cattle for home-grown foods were £3 10s. 0*d.* per ton for clover hay, £2 10s. 0*d.* for meadow hay, £1 for barley straw and 15s. for roots.

On the majority of farms where winter fattening is important, there is no other outlet for straw, hay and roots. To sell these at the prices mentioned may or may not be regarded as good business, but, at any rate, the cattle have given these prices for them.

Then, if the cattle are regarded primarily as producers of manure, it may be said that they have made it at a cost of 5s. or 6s. a ton. Farmers will differ in their opinion as to whether farmyard manure in the yard is worth 6s. a ton, when account is taken of the cost of carting and spreading it. A great deal will depend on the crops for which it is to be used. If for a cash crop, such as potatoes, or vegetables, it will probably be regarded as good value; if, on the other hand, it is simply to be used "to produce roots at a loss to feed more cattle at a loss," the position is different.

It is necessary to note that in the investigation described, the cattle when purchased cost 39s. 7*d.* a cwt., and when fat realized 47s. 8*d.* per cwt. including the subsidy. The margin of 8s. 1*d.* per cwt. is less than that obtained in some winters, but is probably not far from the average of recent years.

At best, it is obvious that winter fattening cannot be regarded as a direct source of profit under average conditions and in the majority of seasons. It is, therefore, mainly restricted to arable farms where an outlet must be found for straw and roots and where farmyard manure is required for arable crops. Most grass districts also have a great deal of winter food in the form of hay, but the quantity can be roughly regulated according to the number of cattle which it is desired to keep during the winter months, instead of the supply of winter food determining the number of cattle to be fed. Also, in grass districts where cattle are to be maintained in the winter, the stock is

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usually a permanent one consisting largely of cows and young cattle. Such animals will generally give a better return for hay than will two-year-old bullocks, which can quite well be fed on straw and roots with the addition of some concentrates.

Arable farms, wherever they occur, are, therefore, those on which winter fattening is found, and the eastern counties of England and Scotland are thus much the most important areas in which it is practised. The relative numbers of cattle in June and in December in the different counties indicate the position fairly well. The counties of the south and east of England, ranging from Dorset to Durham, show a larger winter population than that recorded for June; the grass counties of the west and the Midlands have either about the same numbers in winter and summer, or a lower winter population. Figures are not available for Scotland, but it is practically certain that the relative position of the west and the east is the same there.

In all these arable counties, the reasons for the practice of winter fattening are fundamentally the same, but there are important differences in the details of management, arising largely from climatic conditions.

Housing. Almost everywhere it is customary to keep the cattle indoors, partly to avoid the loss of heat and energy which results from outdoor feeding in winter, partly to conserve the value of the farmyard manure, and partly to avoid the damage which would be done to most land by trampling with cattle in winter.

The systems of housing vary a good deal from north to south. In the north, substantial stone or brick buildings are common, and in Aberdeenshire, many of the cattle are tied up in byres. This system enables a skilled stockman to feed each animal according to its individual needs, and there can be no doubt that the high reputation of the county for the winter fattening of cattle largely depends on the advantage taken of this opportunity. It is economical of space, and in a district where substantial buildings are regarded as essential the heavy capital costs are spread over a large number of cattle. It also has the important advantage of preventing bullying on the part of the stronger beasts and of enabling the farmer to market and to replace the cattle as each becomes fat, instead of having to wait until a whole group is ready. (It is impossible to introduce one or two new beasts into a group which is being fattened in

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a yard.) For bullocks, a serious drawback is the difficulty of keeping the stalls clean and comfortable without the use of excessive quantities of bedding. Still more important is the daily labour of handling the manure and the difficulty of utilizing the liquid. As the reason for winter fattening is largely the need for producing farmyard manure, the last consideration is often vital, so that in most districts indoor fattening of cattle is practised in sheds or boxes, where, if desired, the manure can be allowed to accumulate under the feet of the cattle until the end of the fattening period. Under such conditions, the day to day labour, as far as the manure is concerned, simply consists of spreading straw as bedding; loss either in the form of drainage or in the escape of ammonia is reduced to a minimum, and the manure can be carted out and applied directly to the land whenever convenient.

The construction of the feeding sheds varies according to climate. In the east of Scotland and down into Yorkshire, the sheds are substantially built, many with slated or tiled roofs, though those put up in recent years have usually had asbestos or corrugated zinc roofs, or the Yorkshire type of cheap creosoted timber roof. South of the Humber, less protection is needed, and, as one proceeds south, the completely covered shed is gradually replaced by partly open yards, particularly in the districts where there is no reason for producing farmyard manure of high quality, and the main requirement is the treading down of large quantities of straw.

Cost of labour, though of much less importance than the cost of feeding stuffs, is still a considerable item, and varies considerably according to the layout of the shed, and its position in relation to food stores, straw barn and root house. Probably Angus contains some of the best illustrations of feeding sheds which make provision for the sub-division of a large number of cattle into comparatively small lots, but all under one roof and fed with the minimum of effort. In that county potatoes are a very important crop, and cattle feeding for the production of farmyard manure is viewed as an essential accessory.

Feeding. If farmyard manure is to be produced at a reasonable cost, it is necessary to keep the purchase of concentrates to moderate amounts, but, again, there is considerable difference as one moves from north to south. Generally speaking, in the north the quantity of purchased food is small,

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and dependence is mainly placed on home-grown straw and roots. In the south, particularly perhaps in Norfolk, expenditure on concentrates is much heavier.

This practice reflects the general belief that roots and straw grown in the north are of better feeding value than those grown in the south. As regards roots, there is definite evidence that this is so. Lauder, reporting on the work of the Scottish Committee appointed to investigate the composition of swedes, has shown that, swedes grown in Aberdeenshire contained as much as 14 per cent. dry matter compared with only about 10 per cent. in the same varieties similarly treated in the south-west of Scotland. Further south, the percentage of dry matter may be lower still, and in north Wales is frequently only 8 or 9 per cent. The difference is probably quite as important in the case of straw. In the north, the bulk of the straw fed is oat straw; from Yorkshire southwards, the proportion of oat straw is much less, and barley straw becomes more common. Even where oat straw is fed, it has not the same value in the south as in the north. To some extent, this is partly a matter of variety, as oats of the "Potato" type which are largely grown in the north have a much greater proportion of leaf than those generally grown in England. Further, the ripening in a comparatively cool climate favours a sweeter and more palatable straw than can be obtained in the hotter regions of the south.

There are, however, other reasons which are often overlooked. In Scotland, grain is stacked in small ricks, and much of the threshing is done by a fixed machine in the farm stead-ing, at short intervals during the winter; the result is that the cattle continually have freshly threshed straw, and this is undoubtedly far more palatable to them than straw which has been threshed for some time. It is also possible that many threshing machines on small farms do not separate the grain so effectively as the large travelling outfits under the charge of expert operators, which do most of the threshing south of the Border. Whether this is so or not, it is certain that it is more difficult to thresh efficiently in the north than in the south.

Formerly, it was the custom in many districts to give roots as well as straw *ad lib*, and a big three-year-old bullock, such as was then often favoured, would consume as much as $1\frac{1}{2}$ cwt. a day. The wastefulness of this is now realized, and, usually the maximum fed is the quantity which the bullock will take to satisfy his requirements for water. With a two-year-old

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bullock this generally means that the maximum fed is not more than about 80 lb. a day.

Selection of Cattle. Just as in the case of summer fattening, the results obtained in winter fattening depend very largely on the judgment exercised in the purchase of store animals. A large proportion of the cattle used for this purpose are of Irish origin. The Report of the Livestock Commission shows that, of the fat cattle certified in March, 1938, 26 per cent. in England and 38 per cent. in Scotland were imported cattle. As these figures cover all parts of the respective countries, and include western districts, where the cattle are mainly home bred, it is certain that the figures for the arable districts of the east would be much higher. A large proportion of the Irish cattle are now polled Aberdeen Angus crosses. The absence of horns makes them very suitable for yard fattening, and in general quality they compare favourably with home bred cattle, which nowadays frequently show the effects of the increasing attention given to milk production in our rearing districts. It is also necessary to exercise considerable care in the subdivision of the stores into groups, which will settle down together, will progress at a similar rate, so that one ration will be suitable for all, and will all be fat about the same time, so that their part of the shed may be cleared all at once, and, if necessary, refilled with another lot. Store cattle as bought in most markets have usually been derived from a number of different farms, and, when put together, take some time to settle down amicably, even if there is not a persistent bully, or, on the other hand, a weakling or two. When not eating, fattening cattle should be quietly resting, and the financial results will depend very largely on the extent to which this is attained. As in all kinds of stock management, success very largely depends on the skill and care of the man entrusted with the actual feeding and management.

FARMING IN THE NORTHERN COUNTIES

Northumberland : Durham : Cumberland : Westmorland

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In the minds of the uninitiated, the " north " is closely associated with industrial, rather than agricultural activities, and any reference to it is apt to conjure up mental pictures of gaunt chimney stacks and pithead gear; of factories, mines, and mills; of silhouetted cranes and gantries; of evening skies red with the glow of blast furnaces and coke-ovens; of an atmosphere a-hum with the rumble and rattle of machine shops and shipyards; and a countryside blackened and scarred with the unsightly waste heaps and sooty discharges of industrial plants of one kind and another.

The initiated, however, know better. That the north country is highly industrialized in parts, there is no gain-saying. There are the shipyards, quays, and coaling staithes on the Tyne, the Wear and the Tees; the blast furnaces on Teeside, in north-west Durham, and in West Cumberland; the many collieries and associated by-product works which, during the last century and a half, have undermined the greater part of Durham, south-east Northumberland and the Cumberland seaboard near Whitehaven; the very modern chemical manufacturing plant in south-east Durham; and the scattered, derelict sites left by other industries which have long since had their day. These are the outward and visible signs of industrial activities which contribute largely to the economic pattern of the 5,300 square miles of territory which stretches southwards from the Tweed to the Tees, and from the Solway Firth to Morecambe Bay, and which constitutes the Northern Advisory Province in the Ministry's scheme of agricultural education and research.

The dominance of the non-agricultural industries, however, is a strictly localized feature of the Province, and the initiated need no reminder that here also is the birthplace of the Short-horn breed of cattle and the stronghold of its dual-purpose type; the nursery of the Cheviot, and the Half-bred sheep; and the cradle of phosphatic manuring. It would be difficult to find a comparable region which offers such a complete range

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of grassland farming, embracing, as it does, all stages from first-class feeding pastures on the coastal plains, to the thinnest and roughest of high fell grazings where only the hardy and picturesque little Herdwick sheep can hope to find subsistence. Here also are substantial areas in which "alternate husbandry" has been practised for many years. Here, indeed, is the complete integration of livestock husbandry on a regional, rather than a farm scale, as the cattle and sheep, bred and reared in the sheltering folds of the upland grazings, move down to fulfil their appointed purpose on the leys, and in the courts and byres of the lowland farms.

To see the farming of the northern counties in due perspective, it is helpful to appreciate first their main physical and economic features. Though the area falls nothing short of other like areas in the diversity of its farming, so far as local variations of type and system are concerned, these local differences may nevertheless be discounted for the purpose of a general survey such as is intended here. The broad pattern of the farming over relatively wide areas is conditioned by factors, physical and economic, which can be simply, yet adequately, outlined in general terms.

In its general topography, for example, the province consists of centrally disposed hill masses, which fall away, gradually to the east and almost precipitously to the west, to the coastal plains. Thus, in the north, along the Anglo-Scottish border lie the Cheviots, rising, in the Cheviot itself, to 2,676 ft. above sea level. Southwards from the Cheviots, through the centre of the province, stretch the Pennines, the "backbone of England" which reach their highest point in Cross Fell (2,930 ft.) and which form an almost unbroken barrier to free communication between east and west. Between the Pennines and the Irish Sea, and separated from the former by the sheltered valley of the river Eden, stand the massed crags and fells of the Cumbrian Hills, several of whose peaks are above 3,000 ft., and within whose folds lie the English lakes.

The coastal plains themselves are nowhere more than about 20 miles wide, and, in some places—as, for example, opposite Holy Island in north-east Northumberland, or where the massive shoulders of Scafell and the Wastdale Scree press upon the coast at Seascale in West Cumberland—the plains are only a mile or two wide.

The influence of altitude upon the farming of the province

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may be gauged from the fact that probably as much as 70 per cent. of the total area lies above the 400-ft. contour, and somewhere about one-sixth above 800 ft.

These topographical features explain largely why, out of a total agricultural area of nearly three million acres, over 40 per cent. (1,219,079 acres in 1937) consists of rough grazings, i.e., nearly one-quarter of all the rough grazings in England and Wales. They also have a great deal to do with the significance of the north country as a breeding and rearing ground for cattle and sheep. The high, thin-soiled moorlands, open, wind-swept and treeless, are essentially sheep country, while, at lower altitudes, the sheltering folds of the many steep-sided dales, and gills, and denes, through which innumerable brooks, burns and minor streams burble their way from the hill-tops to swell the main rivers, provide the more fertile "in-bye" pastures, meadows, and grazing slopes which are an essential complement to the upland grazings in the management of hill flocks and herds.

The central watershed naturally divides the province into eastern and western divisions, and since the prevailing winds throughout the greater part of the year are westerly and south-westerly, there are notable climatic differences on either side. On the drier side in the east, the annual rainfall averages about 26 in., with drier localities (23 in.) near Berwick-on-Tweed and on Tees-side in south-east Durham. The east is also subject in February and March to cold north-east winds against which there are no sheltering hill barriers.

In the west, the rainfall is heavier, the general average being about 40 in. Locally, however, there are wide variations. The centre of the Carlisle plain is relatively dry (25-30 in.); around Kendal in south Westmorland the average is over 50 in., and, in the centre of the Lake District itself, an annual fall of over 100 in. is not unknown. On both sides the close proximity of the sea narrows the range between winter and summer temperatures, the west in particular enjoying the moderating influence of the Gulf Stream. It is interesting to notice, for example, that on the narrow coastal plain in West Cumberland, snow is practically unknown, although a few miles away the hills may be snow covered for considerable periods.

The frost factor, however, is important. Pooling of cold air in the pockets, and folds of the hills makes certain localities very susceptible to frost in the late spring and early autumn,

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and thus exerts a limiting influence upon horticulture and market gardening developments.

By comparison with the flatter and more southerly parts of the country, the northern counties as a whole are much less subject to drought and are comparatively free from floods. Apart from an occasional "spate" after heavy rains on the hills, the area most subject to floods is in the immediate vicinity of Carlisle.

Of the economic factors which influence the variation of farming types within the province the density and distribution of the population is of major importance. The position is illustrated by the following figures taken from the 1931 census.

POPULATION DENSITIES IN THE NORTHERN COUNTIES. 1931 CENSUS.

		<i>Total Population</i>	<i>Per 100 Acres</i>
Northumberland	.. ..	757,000	60
Durham	.. ..	1,486,000	237
Cumberland	.. ..	263,000	27
Westmorland	.. ..	64,500	13

The two eastern counties claim eight towns (of which six are in Durham) with populations exceeding 50,000, and thirty-two towns, with more than 10,000 inhabitants. In striking contrast, there are only four towns in Cumberland and Westmorland with more than 10,000 inhabitants, and only one, Carlisle, with more than 50,000. Moreover, out of the total population of Durham and Northumberland, amounting to nearly 2½ millions, rather more than four-fifths are located in a narrow strip of country, about twenty-four miles wide, extending from the River Tees to about 20 miles north of Newcastle-upon-Tyne. This small, but well defined district is the north-east coast industrial area, whose chequered economic experience during the post-War years has provided some of the most intractable problems of unemployment relief.

The only other industrial concentration in the province is in the neighbourhood of Whitehaven, Workington, and Maryport in West Cumberland where coal and ironstone mining are carried on. This, also, is one of the "Special Areas" in relation to industrial unemployment.

It will be readily understood that, from an agricultural marketing standpoint, the greater part of Northumberland, and practically the whole of Cumberland and Westmorland are exporting areas, while the industrialized parts of Durham and

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Northumberland are consuming and importing areas, in which farming incomes are more than usually sensitive to the fluctuations in the purchasing power of the local industrial population.

Against this general background it is now possible to indicate the more prominent features of the farming proper. For this purpose, the province may be divided, rather arbitrarily, into three main areas. These are:—

- I. The East Coast Lowlands, consisting of :—
 - (a) the industrial belt ;
 - (b) the mid-Northumbrian plain ;
 - (c) Tweedside.
- II. The Hill Country, comprising the higher slopes of the Cheviots, Pennines and Cumbrian Hills.
- III. The North Cumberland Plain.

It may be noted in passing that a recent agricultural survey distinguishes no fewer than twenty-one "farming-type districts" in the province and readers who seek a detailed description of local areas may be referred forthwith to the published report of that survey.* Present considerations of space compel much broader treatment here.

Throughout the heavily populated industrial belt the general character of the farming is dictated by the demands of a large consuming market at close range. The mixed dairy and cash cropping farm predominates, though by no means exclusively. In various combinations, milk, beef, mutton, pigs (chiefly for pork), eggs and poultry, potatoes, wheat, and, to a small extent, the coarser vegetables, are produced for direct sale within the area.

The milking herds include all the common breeds, with Shorthorns predominating, and are maintained usually by the purchase of down-calving cows, as required, from the breeding areas lying to the west. The culled cows are fattened and sold locally in competition with beef cattle proper from the feeding areas farther north.

Though the bulk of the milk produced is sold through wholesale or semi-wholesale channels, the proportion of producer-retailers is high, and production to graded standards has made excellent progress.

Most of the farms in the area have maintained their arable

* *An Agricultural Survey of the Northern Province.* By Hanley, Boyd and Williamson, published by the Department of Agriculture, King's College, Newcastle-on-Tyne. 1936.

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acreages and their demand for labour substantially better than most parts of the country despite the industrial competition. Three factors have operated in favour of this tendency. The area has experienced a long period of severe industrial depression and the earnings in the main non-agricultural industries—coal, shipbuilding and steel—have been, if anything, lower than the earnings of farm workers. Moreover, regular farm workers in the north country still have the security of the long-term hiring agreement, and thirdly, over large parts of the area, the effects of underground subsidence and atmospheric pollution compel frequent use of the plough to maintain the leys in reasonable condition.

Years ago, before mining transport above and below ground became mechanized, the collieries provided a valuable market for locally-grown oats and hay. This market has declined, though oats is still the main cereal. The wheat acreage, however, has doubled since 1928, while the acreage under barley has declined by 63 per cent. since 1924. Potatoes occupy a substantial part of the root breaks.

Two interesting local features may be noted briefly here. One is the important economic and social rôle played throughout the area by the allotment, which is usually a vegetable garden producing for home consumption, and often large enough to accommodate a small piggery, greenhouse, or poultry run. Practically every town and village has its association of allotment holders.

The other feature is the appreciable amount of agricultural land owned by colliery companies and industrial undertakings. Ownership allows the companies to deal more readily with recurrent claims from tenants for damage to crops through subsidence and pollution. Recently there has appeared a tendency to let farms "free of damage."

North of the coalfield and extending over the greater part of the Northumbrian coastal plain is an area of considerable interest and significance, not merely in the local sense, but to agriculture in all parts of the world. A few miles north of Tyneside, the loams and alluvial soils overlying the coal measures give place to boulder clays, of varying quality, which are characteristic of a great part of Northumberland. This is the type of land whose responsiveness to phosphatic manures was so strikingly demonstrated by the historic plots laid down at the Cockle Park Experimental Station, three and a half miles north of Morpeth.

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Throughout this area, basic slag, mineral phosphates and lime, combined with controlled mixed grazing under skilled management, have produced many outstanding examples of grassland improvement. Much of the land has been under the plough at some time or other, and it may be claimed that the ideas underlying the recently introduced land fertility scheme have been incorporated in the standard practices of the area for many years past. The farms are large, ranging up to 2,000 acres, of which up to one-third may be arable. Swedes, or turnips and oats, grown for winter forage, are the main arable crops. The wheat acreage, however, has responded strikingly to the encouragement given by the Wheat Quota Act, and for the county as a whole, the 1937 acreage was three and a half times the 1928 acreage.

The pastures are grazed by cattle and sheep for the production of high quality beef, lamb and mutton. The cattle are mainly first and second cross Angus-Shorthorns, or, where the land rises to the west, Shorthorn-Galloways. Large numbers of Irish cattle are imported regularly into the area, but the subsidy-preference in favour of home-grown stores has given encouragement to the production of home-bred sucklers in the sheltered parts of the foothills of the Cheviots and Pennines adjacent to the plains. The fatstock markets of Belford and Alnwick are notable centres for the sale of super-grade cattle.

Most of the feeding farms maintain flocks of Half-bred ewes, which are crossed by Down rams, commonly the Suffolk or Oxford, for the production of fat lambs. The Half-bred, of course, is the well-known cross, by the Border Leicester ram out of the Cheviot ewe, whose mothering qualities and high fecundity under suitable conditions have established its reputation in areas farther afield. Not all boulder clays are of good quality, however, and on the poorer grazings, mules (Border Leicester x Scottish Blackface) or pure Blackfaces may be preferred. Lambing begins on the lowland farms from the turn of the year onwards, and fat lambs appear in the local fatstock markets just before Easter. Lambs not finished off the grass are carried over as hoggs to finish on the root breaks.

Some winter feeding is still carried on, but the low level of fatstock prices during recent years has discouraged the practice in favour of summer grazing, and evidence collected by the writer shows clearly that, but for the fatstock subsidy, the

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position of many of the graziers would be extremely critical. Throughout the area the arable acreage has declined in conformity with the national trend in this direction.

Although still essentially a feeding area, there are several outstanding examples of successful milk producing farms, carrying excellent pedigree herds of Ayrshire, Friesian, and Shorthorn cattle.

In the extreme north of the province, embracing the valleys of the Tweed, and its tributary the Till, there is a small but distinctive area of high-class farming. Here the soils are variable, consisting of loams and clay loams, sands and gravels. The proportion of land under the plough is high generally, and in some instances as much as 70 per cent. of the total farm acreage. The farms themselves are substantial in size, capitalization, and equipment.

As a whole the area is so adaptable that generalization about its practices is by no means easy. Traditionally it has followed a four- to six-course system of cropping—roots, barley, seeds (1-3 years), oats—combined with the maintenance of a Half-bred ewe flock and round the year feeding of fat cattle. The vagaries of prices during the last twenty years, however, have induced many departures from the general system. The temporary leys, however, remain an outstanding feature of the area, both for the skill with which the pastures are built up, and the enterprise shown in their management and utilization.

The main output of the Tweedside area consists of beef cattle, fat lambs and hogs, barley, potatoes and sugar-beet. The cattle are largely imported Irish stores, Angus x Shorthorn and Blue-greys (Shorthorn x Galloways). Increasing numbers of homebred sucklers from the rearing-grounds in the adjacent foothills are now finding their way to the leys and feeding courts.

The Half-bred ewe is practically universal throughout the area, and on many farms the ewe-flock is the king-pin of the system. The district has long been noted for its output of first-class, heavy-weight hogs.

Though the scale of barley growing has declined, good malting samples are still produced, and, as elsewhere, the wheat acreage has extended noticeably.

The root breaks on Tweedside are more varied than anywhere else in the province and include swedes, turnips, potatoes, sugar-beet, kale, cabbage, and mangolds. This is,

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in fact, the only part of the province in which the growing of sugar-beet has persisted since the crop was introduced on the farm scale in 1926, but the nearest factory, unfortunately, is at Cupar, in Fifeshire.

Amongst other measures taken to win through the post-War depression note might be made of the development of the breeding and feeding of pigs, and the extension of poultry farming. As the nearest consuming markets, however, are centred on Edinburgh and Tyneside, 60-70 miles distant either way, these branches of husbandry, alike with milk production, may not make much further headway.

The hill country, which falls next to be considered, may be dealt with briefly without underrating its significance. It consists of high, treeless, windswept, bleak and remote moorlands, mainly bent-covered, with occasional patches of bracken and heather. Large stretches bear all the signs of defective and neglected drainage. The farmsteads are widely scattered and many of them difficult of access. Here the hill sheep breeds hold sway. On the Cheviot Hills the Cheviots and Scotch Blackfaces share the ground; farther south over most of the Pennine uplands, the Blackfaces predominate as far as the Yorkshire borders, where they meet the strong Swaledales. The high fells of the Lakeland Hills are the preserves of that distinctive and picturesque mountain breed, the Herdwick.

Some of the hill flocks are of considerable size, the larger holdings extending to thousands of acres, though the density of stocking may be no heavier than a ewe per three acres or so. On the other hand, there are many farmers of substance in the province who have graduated in the hard school of experience from the shepherding of a small hill "hirsell." Here and there, the flocks are "hefted," that is, bound to their particular hills by acquired resistance to diseases which are all too prevalent. In some areas also, particularly in Upper Weardale, Allendale, and parts of Cumberland, common grazing rights are shared upon the open fells.

The importance of these hill flocks as reservoirs of the pure breeds from which the crossbred lowland flocks are regularly replenished, may be gathered from the fact that, in December, 1937, the northern counties contained no less than 16 per cent. of the total sheep population in England and Wales.

Before moving to the more congenial environment of the Cumberland Plain, reference must be made to the herds of

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pure Galloway cattle which are to be found in the area centred upon the Bewcastle Fells, north of Haltwhistle, and on the higher slopes of the Cumberland Hills. Crossed by the White Shorthorn bull, these herds produce the blue-grey cattle which respond so well when brought down to the richer pasture and kindlier environment of the lowland feeding areas.

The remainder of the province consists of the lowlands of Cumberland and Westmorland, where the main interest lies in the breeding and rearing of Shorthorn cattle. Despite the increasing influence of modern transport and milk sales organization, the farmers throughout the greater part of this area are stockmen by tradition and environmental influence. The breeder's art does not lend itself readily to large-scale organization, and the large proportion of small farms, with their herds of deep-bodied, well-fleshed Shorthorns—the dual purpose type with which the two counties have long been associated—provide ample scope for the exercise of individuality and the stimulus of friendly rivalry in the sale-ring at Penrith, where the periodical sales of pedigree and non-pedigree stock attract buyers from all parts of Britain as well as from overseas.

Breeding activities, however, are not entirely confined to cattle and sheep. Cumberland claims its own breed of pigs, and the horse-sales at Wigton are well known as a market for locally-bred Clydesdales of quality. Poultry, also, are well distributed throughout the area and contribute substantially to the total farming output.

During recent years, however, the economic trend has induced an appreciable change-over to liquid milk selling at the expense of stock rearing and butter making. The trend is particularly noticeable in the neighbourhood of Wigton and the Carlisle plain, where the characteristic Cumberland Shorthorns have given place, on many farms, to various crosses of the established milk breeds. Ayrshire x Shorthorns, in particular, have invaded the area in some force. The majority of the herds, however, are still maintained by home-breeding, and the prevailing practice is to sell out surplus third- and fourth-calf cows to the areas farther east (Durham, etc.).

There being no considerable local population, the bulk of the milk produced throughout Cumberland and Westmorland is sold by wholesale, and it is significant that, at Aspatria, 20 miles west of Carlisle, the Milk Marketing Board

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established one of its earliest factories for handling surplus milk.

Cropping practices are dictated by the needs of live stock, the relatively heavy rainfall, and the absence of a local consuming market. The only cash crop of any note is potatoes, and it is significant that these are quoted by the stone on local markets. On the other hand it is of more than local interest to note that a small group of farmers in the neighbourhood of Penrith, co-operating as the Cumberland Seed Potato Growers' Association, produce Class I English Special Stock Seed in accordance with the Ministry's regulations. The Association have been particularly successful in grading-up stocks of the "crisping" variety Bintje.

Turnips and swedes, however, dominate the root breaks, and folding by sheep (mainly Cheviot hoggs) is extensively practised. The corn crop is almost exclusively oats, both grain and straw being consumed locally.

In the Lake District proper, and in the adjacent areas, farming incomes benefit from the influx of holiday makers during the summer. The season, however, is comparatively short.

This survey of north country agriculture would be incomplete without some reference to the important and extensive experiments which are now in progress, in the settlement of unemployed industrial workers upon the land. In Cumberland, Northumberland and Durham, numerous colonies of whole-time and part-time holdings have now been established and equipped for market gardening, poultry- and pig-keeping. Moreover, in certain parts of the Lake District and in Northumberland, the Forestry Commission have been actively engaged during recent years in afforestation programmes covering many thousands of acres.

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Wheat (Amendment) Act, 1939.

The Wheat (Amendment) Act, 1939, which became law on July 13, effects a number of amendments in the Wheat Act, 1932, which experience of the working of that Act had shown to be desirable. The amendments are largely of an administrative and technical character and the broad principles governing the making of deficiency payments to wheat growers remain unaltered. The following is a brief summary of the provisions of the Act in so far as they are of interest to wheat growers and farmers generally.

Section 1 provides for the appointment of a Committee of three persons in 1939, and subsequently at intervals of three years, to consider and report to the Minister whether any alteration is desirable in the standard price of wheat for the purposes of the Wheat Act. The standard price established by the Act of 1932 was the price of 45s. per qr. and the Committee appointed in 1935 under the Act recommended that no alteration should be made in the standard price at that time. The Committee suggested, however, that a similar review might be desirable after a further period of years, and the Act of 1939 gives effect to this suggestion. The Standard Price Committee of 1939 was appointed by the Minister on July 14, and consists of Sir Harry Peat, K.B.E., F.C.A. (Chairman), Mr. W. R. Smith and Mr. Cyril Lloyd. If the Committee recommend that the price should be altered, the Minister may make an Order, subject to confirmation by Parliament, substituting such price as he thinks fit. Any communications for the Committee should be addressed to the Secretary, Mr. W. C. Tame, 10, Whitehall Place, S.W.1.

Section 2 contains provisions whereby in future any person who purchases growing wheat, or wheat cut but not threshed, will be entitled to claim deficiency payments when he sells the wheat as threshed wheat. In some cases under the Act of 1932 the seller of such wheat could not be deemed to be the

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grower and the Wheat Commission had no power to make deficiency payments in respect of the wheat.

Sections 4 to 9 relate to the liability of millers and importers of flour to make quota payments. In the first place, new definitions, based upon ash content, of "flour" and "wheat by-products" (the new term now applied to "wheat offals") are prescribed, and provision is made for quota payments to be levied in accordance with a diminishing scale on low grade flour destined for live stock. Secondly, new conditions are laid down in Section 7 governing the quota free sale of wheat-meal. Under the Act of 1932 wheatmeal could be sold free of quota payment provided it was produced in the United Kingdom and delivered for consumption, without further manufacture, as animal or poultry food. Under the Act of 1939 the restriction upon "further manufacture" is removed and it will be permissible for quota-free substances to be manufactured into cubes or pellets without rendering the miller liable to quota payments. At the same time the exemption is extended to any form of flour which is destined for live stock and conforms to the admixture requirements laid down in Section 7.

Section 7 distinguishes the following four categories of flour which are exempt from quota payment provided they are produced in the United Kingdom and are destined for live stock:—

1. Wheat provender mixture, *i.e.*, any mixture containing not more than 50 per cent. by weight of wheatmeal or other flour. If the ash content of the wheaten part exceeded 2·7 per cent. the parcel would be wheat by-products and would not require admixture in order to secure exemption.

2. Flaked or rolled wheat mixture, *i.e.*, any mixture, the wheaten part of which consists only of flaked or rolled wheat and does not constitute more than 75 per cent. by weight of the mixture.

3. Cut wheat, *i.e.*, cleanly divided fragments of whole wheat free from meal or dust.

4. Multure meal, *i.e.*, any wheatmeal or flour which is delivered to the grower who grew the wheat from which it was produced and who intended to use it for feeding to his own livestock. This provision is designed to suit the local custom of "multure" in Northern Ireland and no deficiency payments are made on wheat used in the production of meal.

Provision is further made that, where a miller includes more than the permitted percentage of wheat in his mixture when producing wheat provender mixture or flaked or rolled wheat mixture, he shall be liable for quota payments only in proportion to the excess of the wheaten part over 50 per cent. or 75

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per cent. of the mixture as the case may be. Under the 1939 Act, as under the Act of 1932, any miller whose deliveries consist only of wheat provender mixture and other substances referred to in the previous paragraph may obtain from the Wheat Commission a provender miller's certificate certifying that he is exempt from quota liability.

Section 23 of the Act empowers the Wheat Commission to make grants or loans in aid of research and education in regard to the growing, marketing or utilisation of wheat. The remaining sections are concerned with the imposition of quota payments on breakfast foods, the machinery for the collection of quota payments and other matters of administration. Copies of an explanatory leaflet on the Wheat Acts 1932 and 1939 may be obtained free and post free on application to the Ministry.

Auto-Sex-Linked Poultry Breeds

Stocks of the new Cambridge breeds of poultry will again be available for the public in the autumn. The characteristic of these breeds is that the sexes of the chicks at hatching can be told at a glance by the markings on the downs. The oldest of these breeds, the Cambars, are available in the gold and silver varieties. They are medium-sized, compact and close-feathered, of laying type, with white skin and shanks. The sex-distinction in the downs of the newly-hatched chicks is especially well marked in this breed; it is clear, constant and foolproof. The Legbar (or Barred Brown Leghorn) is of the Leghorn type. Those who already have Brown Leghorns can proceed most easily by putting a Legbar cock to their own Brown Leghorn hens. For the pullets from this cross are pure Legbars and can be used for breeding straight away. Normally, Legbars have yellow shanks and skin, but a variant with white skin and shanks is also available; it has an obvious attraction to the breeder with an eye on the table market.

The newest addition to these auto-sex-linking breeds is the Barred Buff Orpington (Buffbar). This has the large frame of the Orpington; indeed, except for the faint barring on the feathers, the Buffbar resembles the Buff Orpington in appearance and performance, but it carries, in addition, the sex-distinction in the downs of the newly-hatched chicks. A few specimens of this breed will be available for distribution to the public. Enquiries for stock of all the above breeds may be made to Mr. M. S. Pease, School of Agriculture, Cambridge.

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Marketing Notes

Livestock Industry Act, 1937: Cattle Fund. For the three months, April to June, 1939, payments in respect of fat cattle subsidy amounted to £1,108,694, and the number of animals covered by these payments was 387,837, giving an average payment of £2 17s. 2d. per animal. The figures for the corresponding months of last year were—total amount paid £995,451, number of animals 358,283, and average payment per animal £2 15s. 7d. The percentages of animals conforming to the "quality" standard in the two periods mentioned were 71 and 63 respectively.

Livestock Advisory Committee. Mr. G. Gibbard and Mr. G. P. Stephens, representatives of the National Farmers' Union, have been appointed members of the Livestock Advisory Committee.

Imports of Processed Milks. In connexion with the Processed Milk (Import Regulation) Order*, which came into operation on June 19, 1939, allocations as set out below have been made for the next two years to the supplying countries concerned. In total, these represent a reduction as regards condensed whole milk of 34 per cent., skimmed milk 18 per cent., and milk powder 35 per cent. on the imports of 1938. The cream allocation is somewhat higher than imports in 1938 owing to the temporary decline in that year in shipments from Eire.

QUANTITIES (CWT. PER ANNUM) TO BE IMPORTED ANNUALLY FROM SUPPLYING COUNTRIES.

	Condensed Whole Milk	Condensed Skimmed Milk	Milk Powder	Buttermilk and Whey Powder	Cream
Eire ..	22,000	100,000	10,000	—	40,000
New Zealand ..	30,000	—	115,000 (a)	12,000	—
Canada ..	108,000	—	25,000 (b)	—	—
Australia ..	—	—	25,000 (c)	6,000	—
Netherlands ..	70,000	800,000	50,000 (d)	12,000	—
Denmark ..	34,200	94,000	1,320	—	28,900
U.S.A. ..	4,000	—	4,000	—	—
Switzerland ..	3,000	—	500	—	—
Belgium ..	3,000	3,000	1,000	—	—
Italy ..	—	1,500	—	—	—
Estonia ..	1,200	—	—	—	—

(a) 26,250 cwt. full cream.

(b) 6,250 cwt. full cream.

(c) 50 per cent. full cream, 50 per cent. skimmed.

(d) All skimmed.

* See the July issue of this JOURNAL.

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Milk Industry (No. 2) Bill. This Bill, which received its third reading on July 14, and was introduced into the House of Lords on July 17, provides, during a period covering the two years October 1, 1938 to September 30, 1940, for proposals in regard to the following matters, similar to those contained in the Milk Industry Bill (see this JOURNAL, December, 1938) which was introduced last year and subsequently withdrawn:—

- (i) the encouragement of quality milk production by the provision of Exchequer contributions towards the cost of premiums paid on quality milks by milk marketing boards;
- (ii) Exchequer assistance to enable, with the co-operation of the industry, the milk in schools schemes to be continued and schemes to be operated for the provision of milk at reduced prices to welfare authorities in connection with their maternity and child welfare arrangements;
- (iii) putting a bottom in the market for milk sold for manufacture into butter or cheese, by providing for payments to milk marketing boards in respect of such milk, in the event of serious falls in the price levels of imported butter and cheese being sustained over six-monthly periods;
- (iv) the Consumers' Committees appointed under Section 9 of the Agricultural Marketing Act, 1931, to be consulted by milk marketing boards or milk product marketing boards before they exercise powers to determine prices or terms of sale of milk, or milk products, as the case may be.

Milk Marketing Scheme, 1933: *Committee of Investigation for England.* Two complaints as to the operation of the Milk Marketing Scheme have been made to the Minister of Agriculture and Fisheries under Section 9 of the Agricultural Marketing Act, 1931 and have been referred by the Minister to the Committee of Investigation for England.

The first of these complaints, which was submitted by the National Federation of Milk Producer Retailers, relates to the position of producer-retailers in regard to (1) the basis of voting in matters pertaining to the Scheme, and the methods of voting adopted by the Board; (2) Co-operative Societies and the allowance of dividends on retail sales of milk; and (3) the keeping of daily records of production and disposal of milk.

The second complaint was submitted on behalf of Mr. J. A. Thomas, a dairyman, and is concerned with the exercise by the Board of its powers to stop milk supplies.

National Mark Scheme For Brussels Sprouts. The following amendments to the Brussels Sprouts Regulations

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(S.R. & O. 1935, No. 107) made under the Agricultural Produce (Grading and Marking) Acts, 1928 and 1931, have been approved by the National Mark Vegetables Trade Committee :—

- (a) One grade "Selected" to be substituted for the existing three grades "Selected (Extra Small)," "Selected" and "Selected (Large)."
- (b) The transverse diameter of each sprout at the widest part must be not less than one inch and not more than $2\frac{1}{2}$ in.
- (c) The sprouts in any container must be reasonably uniform in size and practically free from loose leaves and from extraneous matter.
- (d) Twenty-five per cent. by count of the sprouts in any one container may depart slightly from the prescribed definitions of size, colour and condition.

Effect is being given to these amendments in fresh regulations.

Marketing Demonstrations. Particulars of Exhibits and Demonstrations to be staged by the Ministry during August are as follows :—

<i>Show</i>		<i>Demonstration</i>	
Royal Lancs, Lancaster	.. ..	Education and Marketing Exhibit.	
Aug. 2-5.		Cinema.	
Sandy	.. ..	National Mark Vegetables and	
Aug. 31.		other products.	

Potato Synonyms

The report of the work of the Potato Synonym Committee of the National Institute of Agricultural Botany for 1938 shows that as a result of their activities the offering of synonyms in the largest seedsmen's catalogues has now been practically eliminated. In arriving at this healthy state of affairs, the Committee has been greatly aided by the very helpful co-operation of the seed trade.

As a result of the examination of this year's catalogues four synonyms were found, as follows :—

<i>Cherub</i>	.. ..	a synonym of	Duke of York.
<i>Lord Allendale</i>	.. ..	" "	King Edward (red type).
<i>Earliest of All</i>	.. ..	" "	Sharpe's Express.
<i>Dreadnought</i>	.. ..	" "	Great Scot.

Apart from these, Midlothian Early, Sir John Llewelyn and Factor are still found in some catalogues. It is hoped that seedsmen will make it clear that these are identical with Duke of York, Eclipse and Up-to-Date, for the use of alternative names, however well known, can only lead to confusion.

PRICES OF ARTIFICIAL MANURES

Description.	Average prices per ton (2,240 lb.) during week ended July 12.				
	Bristol	Hull	L'pool	London	Cost per Unit†
Nitrate of Soda (N. 15½%) ..	£ 8 s.	£ 8 s.	£ 8 s.	£ 8 s.	s. d.
" " Granulated (N. 16%) ..	8 5c	8 5c	8 5c	8 5c	10 8
Nitro-Chalk (N. 15½%) ..	8 5c	8 5c	8 5c	8 5c	10 4
Sulphate of Ammonia :—	7 10c	7 10c	7 10c	7 10c	9 9
Neutral (N. 20·6%) ..	7 14c	7 14c	7 14c	7 14c	7 6
Calcium Cyanamide (N. 20·6%) ..	7 19d	7 19d	7 19d	7 19d	7 8
Kainite (Pot. 14%) ..	2 18	2 15	2 15	2 15	3 11
Potash Salts (Pot. 30%) ..	5 0	5 1	5 0	4 17	3 3
" " (Pot. 20%) ..	3 15	3 12	3 12	3 12	3 7
Muriate of Potash (Pot. 50%) ..	8 3	8 8	8 5	8 1	3 3
Sulphate (Pot. 48%) ..	9 13	10 0	9 17	9 11	4 0
Basic Slag (P.A. 15½%) ..	2 12b	2 5b	—	2 10b	3 2
" " (P.A. 14%) ..	2 8b	2 0b	2 0b	2 6b	3 3
Grd. Rock Phosphate (P.A. 26-27½%) ..	3 5a	3 0a	2 15a	2 10a	1 10
Superphosphate (S.P.A. 16%) ..	3 6h	—	3 2f	2 19g	3 9
" " (S.P.A. 13½%) ..	—	—	2 19f	2 16g	4 1
Bone Meal (N. 3½%, P.A. 20½%) ..	—	7 5	6 17h	6 12	—
Steamed Bone Flour (N. 4%, P.A. 27½—29½%) ..	4 15i	4 15	4 15h	4 12	—

Abbreviations : N. = Nitrogen : P.A. = Phosphoric Acid :
S.P.A. = Soluble Phosphoric Acid : Pot. = Potash.

* Prices are for not less than 6-ton lots at purchaser's nearest railway station unless otherwise stated. Unit values are calculated on carriage-paid prices.

§ Prices are for not less than 2-ton lots, nett cash for prompt delivery, f.o.r., in town named, unless otherwise stated. Unit values are calculated on f.o.r. prices.

a Prices for 4-ton lots f.o.r. Fineness 85% through standard sieve.

b Prices for 6-ton lots. Prices at Bristol are f.o.r. Bridgwater; at Hull and Liverpool f.o.r. neighbouring works and at London f.o.r. at depots in London districts. Fineness 80% through standard sieve.

c For lots of 4 tons and under 6 tons the price is 1s. per ton extra, for lots of 2 tons and under 4 tons, 5s. per ton extra, for lots of 1 ton and under 2 tons, 10s. extra, and for lots of 2 cwt. and under 1 ton, 20s. extra.

d Delivered in 5-ton lots at purchaser's nearest railway station. For lots of 2 tons and under 5 tons the price is 5s. per ton extra, for lots of 1 ton and under 2 tons, 10s. per ton extra, and for lots of 4 cwt. and under 1 ton, 20s. extra.

f Prices shown are f.o.r. Widnes.

g Prices shown are ex works London; f.o.r. southern rails, 1s. 3d. extra.

h Prices shown are f.o.r. Appley Bridge.

i Price shown is f.o.r. Newport, Mon.

k Price shown is f.o.r. Avonmouth.

† These are calculated by regarding a ton as comprising 100 "units" (equal parts of 22·4 lb.) so that a fertilizer, for example, with 16 per cent. nitrogen contains 16 such "units" in a ton. Then, if the price per ton of such a fertilizer be divided by the percentage figure, the deduced cost is that of a "unit" of that agent. Those in the table above are based on London prices. (For further explanation, see Advisory Leaflet, No. 146, "The Valuation of Artificial Manures," obtainable from the Ministry free of charge.)

PRICES OF FEEDING STUFFS

Description	Price per ton	Manu- rial value per ton	Cost of food value per ton	Starch equiv. per 100 lb.	Price per unit starch equiv.	Price per lb. Starch equiv.	Pro- tein equiv.
Wheat, British ..	£ s. 4 10	£ s. 0 9	£ s. 4 1	72	s. d. 1 1	d. 0.58	% 9.6
Barley—Canadian No. 3 ..							
Western ..	5 18	0 9	5 9	71	1 6	0.80	6.2
Australian ..	6 0½	0 9	5 11	71	1 7	0.85	6.2
Iranian ..	5 2*	0 9	4 13	71	1 4	0.71	6.2
Russian ..	6 0†	0 9	5 11	71	1 7	0.85	6.2
Oats, English white ..	6 13	0 10	6 3	60	2 1	1.12	7.6
" black and grey ..	6 13	0 10	6 3	60	2 1	1.12	7.6
Canadian—							
No. 2 Western ..	6 15	0 10	6 5	60	2 1	1.12	7.6
No. 3 Western ..	6 5½	0 10	5 15	60	1 11	1.03	7.6
Mixed feed ..	5 8	0 10	4 18	60	1 8	0.89	7.6
No. 1 feed ..	6 12	0 10	6 2	60	2 0	1.07	7.6
Maize, American ..	5 17†	0 7	5 10	78	1 5	0.76	7.6
" Argentine ..	5 17	0 7	5 10	78	1 5	0.76	7.6
" Danubian ..							
Gal. Fox ..	5 17†	0 7	5 10	78	1 5	0.76	7.6
" Russian, white ..	6 0†	0 7	5 13	78	1 5	0.76	7.6
" South African—							
No. 2 white flat ..	6 2†	0 7	5 15	78	1 6	0.80	7.6
Peas, Russian ..	6 12†	0 16	5 16	69	1 8	0.89	18.1
" Japanese ..	21 0†	0 16	20 4	69	5 10	3.12	18.1
Dari ..	8 0†	0 8	7 12	74	2 1	1.12	7.2
Milling Offals—							
Bran, British ..	5 5	0 17	4 8	43	2 1	1.12	9.9
" Imported ..	5 2	0 17	4 5	43	2 0	1.07	9.9
" Broad ..	5 10	0 17	4 13	43	2 2	1.16	10.0
Middlings, fine, im- ported ..	5 10	0 14	4 16	69	1 5	0.76	12.1
Weatings† ..	5 12	0 15	4 17	56	1 9	0.94	10.7
" Superfine† ..	6 0	0 14	5 6	69	1 6	0.80	12.1
Pollards, imported ..	5 2	0 15	4 7	50	1 9	0.94	11.0
Meal, barley ..	6 17	0 9	6 8	71	1 10	0.98	6.2
" grade II ..	6 5	0 9	5 16	71	1 8	0.89	6.2
" maize ..	6 12	0 7	6 5	78	1 7	0.85	7.6
" " South African ..	5 15	0 7	5 8	78	1 5	0.76	7.6
" " germ ..	6 5	0 12	5 13	84	1 4	0.71	10.3
" locust bean ..	7 5	0 6	6 19	71	1 11	1.03	3.6
" bean ..	9 7	0 18	8 9	66	2 7	1.38	19.7
" white fish ..	16 2	2 6	13 16	59	4 8	2.50	53.0
" Soya bean (extracted)† ..	10 5½	1 12	8 13	64	2 8	1.43	38.3
Maize, cooked, flaked ..	6 19	0 7	6 12	84	1 7	0.85	9.2
" gluten feed ..	6 10	0 14	5 16	76	1 6	0.80	19.2
Linseed cake—							
English, 12% oil ..	9 10	1 2	8 8	74	2 3	1.21	24.6
" 9% " ..	8 17	1 2	7 15	74	2 1	1.12	24.6
" 8% " ..	8 12	1 2	7 10	74	2 0	1.07	24.6

PRICES OF FEEDING STUFFS—(continued)

Description	Price per ton	Manu- rial value per ton	Cost of food value per ton	Starch equiv. per 100 lb.	Price per unit starch equiv.	Price per lb. starch equiv.	Pro- tein equiv.
Linseed Cake—	£ s.	£ s.	£ s.		s. d.	d.	%
American, 5½% oil ..	8 17†	1 2	7 15	74	2 1	1·12	24·6
Indian, 9% oil ..	8 12†	1 2	7 10	74	2 0	1·07	24·6
Cottonseed cake,							
English, Egyptian							
seed, 4½% oil ..	5 10	0 19	4 11	42	2 2	1·16	17·3
Cottonseed cake,							
Egyptian, 4½% oil ..	5 5	0 19	4 6	42	2 1	1·12	17·3
Cottonseed cake,							
decorticated, 7–8% oil	7 15†	1 10	6 5	68	1 10	0·98	34·7
Cottonseed meal,							
decorticated, 7–8% oil	8 0†	1 10	6 10	70	1 10	0·98	36·8
Coconut cake, 5–6% oil	7 2	0 19	6 3	77	1 7	0·85	16·4
Ground nut cake, 6% oil	6 10*	1 0	5 10	57	1 11	1·03	27·3
Ground nut cake, decorticated, 6–7% oil ..	8 10*	1 10	7 0	73	1 11	1·03	41·3
Ground nut cake, imported, decorticated, 6–7% oil ..	7 0	1 10	5 10	73	1 6	0·80	41·3
Palm-kernel cake, 5½% oil ..	6 15†	0 13	6 2	73	1 8	0·89	16·9
Palm-kernel cake meal, 5½% oil ..	6 17†	0 13	6 4	73	1 8	0·89	16·9
Palm-kernel meal, 1–2% oil ..	6 7	0 13	5 14	71	1 7	0·85	16·5
Feeding treacle ..	5 0	0 9	4 11	51	1 9	0·94	2·7
Brewers' grains, dried ale	5 2	0 12	4 10	48	1 10	0·98	12·5
Brewers' grains, dried porter ..	4 15	0 12	4 3	48	1 9	0·94	12·5

* At Bristol.

§ At Hull.

† At Liverpool.

‡ In these instances manurial value, starch equivalent and protein equivalent are provisional.

NOTE.—The prices quoted above represent the average prices at which actual wholesale transactions have taken place in London, unless otherwise stated, and refer to the price ex mill or store. The prices were current at the end of June, 1939, and are, as a rule, considerably lower than the prices at local country markets, the difference being due to carriage and dealers' commission. Buyers can, however, easily compare the relative values of the feeding stuffs on offer at their local market by the method of calculation used in these notes. Thus, if linseed cake is offered locally at £11 per ton, then since its manurial value is £1 2s. per ton as shown above, the cost of food value per ton is £9 18s. Dividing this figure by 74, the starch equivalent of linseed cake as given in the table, the cost per unit of starch equivalent is 2s. 8d. Dividing this again by 22·4, the number of pounds of starch equivalent in one unit, the cost per lb. of starch equivalent is 1·43d. Similar calculations will show the relative cost per lb. of starch equivalent of other feeding stuffs on the same local market. From the results of such calculations a buyer can determine which feeding stuff gives him the best value at the prices quoted on his own markets. The figures given in the table under the heading "manurial value per ton" are calculated on the basis of the following unit prices:—N., 7s. 9d.; P₂O₅, 2s. 6d.; K₂O, 3s. 8d.

FARM VALUES OF FEEDING STUFFS

The prices in respect of the feeding stuffs used as bases of comparison for the purpose of this month's calculations are as follow :—

	<i>Starch equivalent Per cent.</i>	<i>Protein equivalent Per cent.</i>	<i>Per ton £ s.</i>
Barley (imported)	71	6·2	5 15
Maize	78	7·6	5 17
Decorticated ground-nut cake ..	73	41·3	7 15
„ cotton-seed cake ..	68	34·7	7 15

(Add ros. per ton, in each instance, for carriage.)

The Table below is issued as a guide to farmers respecting the feeding value of their crops in relation to current market prices. (The "food values," which it is recommended should be applied by Agricultural Organizers and other advisers in connexion with advisory schemes on the rationing of dairy cows, are given in the December, 1938, issue of the Ministry's JOURNAL, p. 965.)

FARM VALUES

Crop	Starch equivalent Per cent.	Protein equivalent Per cent.	Food value per ton, on farm £ s.
Wheat	72	9·6	6 6
Oats	60	7·6	5 5
Barley	71	6·2	6 0
Potatoes	18	0·8	1 9
Swedes	7	0·7	0 12
Mangolds	7	0·4	0 11
Beans	66	19·7	6 12
Good meadow hay	37	4·6	3 4
Good oat straw	20	0·9	1 13
Good clover hay	38	7·0	3 9
Vetch and oat silage	13	1·6	1 3
Barley straw	23	0·7	1 17
Wheat straw	13	0·1	1 0
Bean straw	23	1·7	1 18

APPOINTMENTS

COUNTY AGRICULTURAL EDUCATION STAFF

Devonshire : Mr. J. S. Symington, B.Sc.(Agric.), N.D.A., N.D.D., as District Lecturer in Agriculture. **Dorset :** Miss R. A. White, B.Sc. (Dairying), as Second Dairying Instructress. **Norfolk :** Mr. W. A. Buckpitt, B.Sc. (Agric.), N.D.A., N.D.D., and Mr. H. G. Hudson, M.A., Dip. Agric., as Agricultural Advisory Officers for East Norfolk. **Nottinghamshire :** Mr. J. A. Collier, N.D.A., N.D.D., as Assistant Instructor in Agriculture. **Staffordshire :** Mr. A. A. Jackson, B.Sc., as Instructor in Horticulture; Mr. J. C. Matthews, N.D.A., N.D.D., as Warden at the Farm Institute and Lecturer in Dairying.

AGRICULTURAL INDEX NUMBER

MONTHLY INDEX NUMBERS OF PRICES OF AGRICULTURAL PRODUCE
(BASE, 1927-29=100.)

Uncorrected for
Seasonal Variation

Corrected for
Seasonal Variation

Month	1937	1938	1939	1937	1938	1939
January	90	97	90	85	90	84
February	91	95	88	86	89	82
March	90	88	85	90	88	85
April	89	85	85	92	89	89
May	81	82	77	88	90	86
June	83	81	75	89	90	83
July	82	86		88	94	
August	83	81		87	86	
September	87	81		89	83	
October	93	86		89	82	
November	99	89		92	82	
December	100	90		92	82	

THE SAME, TAKING ACCOUNT OF PAYMENTS UNDER THE WHEAT ACT (a),
THE CATTLE SUBSIDY (b), AND GOVERNMENT PAYMENTS FOR MILK (c).

Month	1937	1938	1939	1937	1938	1939
January	92	99	95*	86	93	89*
February	93	97	93*	88	92	88*
March	92	91	90*	92	91	90*
April	90	88	90*	93	92	94*
May	83	84	82*	90	92	91*
June	82	83	80*	89	92	88*
July	83	88		89	96	
August	85	84*		89	89*	
September	89	84*		91	86*	
October	95	91*		91	86*	
November	101	94*		94	86	
December	102	94*		94	86*	

(a) Commenced August, 1932. (b) Commenced September, 1934.

(c) Commenced April, 1934. * Provisional.

WIRELESS TALKS, AUGUST, 1939

Station and Date	Time p.m.	Speaker	Subject
WEST :			
10	7.00	Anthony Hurd	For Western Farmers in Particular.
17	7.30	C. D. Ross and T. Robbins	Farming on Exmoor.
NORTH :			
2	7.10	—	Royal Lancashire Show.
3	8.00	Stephen Kirby	Country Fancies (3) : Hedger and Ditcher.

RECENT OFFICIAL PUBLICATIONS

Guide to Current Official Statistics, Vol. 17, 1938.—The diversity of subjects presented in official reports, returns and special surveys is so vast that without special assistance a reference to the whole of the information bearing on a particular subject may entail prolonged research among several hundred volumes.

Invaluable assistance is provided in this Guide, a work produced under the auspices of a committee of official statisticians. Every subject on which official statistics are available is included in an alphabetical list, and on reference to the appropriate heading, the enquirer will find descriptions as regards date, detail and mode of analysis, of all the statistics available, together with a note of the official publications in which they appear. Price 1s. (by post 1s. 5d.).

Tuberculin Tests in Cattle. Agricultural Research Council Special Report Series, No. 4. This Report provides information of both a general and particular nature to all who are interested in the eradication of tuberculosis from the herds of this country. Price 1s. 6d.

NOTICES OF BOOKS

Statistical Technique in Agricultural Research. By D. D. Paterson. Pp. ix + 263. (London: McGraw-Hill Publishing Co. 1939. Price 18s.)

This book is primarily intended for the research worker who wishes to extract the maximum results from his data without trespassing beyond their limitations. With the recently developed technique of mathematical statistics, the boundary of scientific analysis is well defined and there is now no excuse for workers yielding to the temptation of developing arguments unjustified by their material. Mr. Paterson's book will be of real service to those who cherish a scientific conscience.

After dealing with the general principles involved in statistical method and the basic formulæ, the author proceeds to discuss the technique known as the analysis of variance, leading from its simplest form to more complicated examples. With chapters on diagrams, goodness of fit, and the correlation and regression coefficients, the nature of the statistical apparatus, as such, is concluded. With this material at his command, the research worker should have all that is required to deal adequately with his data.

The three final chapters concern the practical aspects of agricultural experimentation. The first of these deals with field experiments, the second with serial experiments, and the third with recent developments in this type of investigational work. It is emphasized that the final analysis of the data has become so highly developed a process that its use necessarily demands a field technique that must be sufficiently exact to justify the later application of the statistical apparatus. In these last three chapters, therefore, the author discusses the general principles of the field work. The sections on incomplete records and the modern design of complicated field trials are particularly valuable.

This book will be greatly welcomed by those working in this particular line, for it is assumed that such research workers have already acquired some familiarity with mathematics.

NOTICES OF BOOKS

The Chemistry of Milk. By W. L. Davies, Ph.D. Second Edition. Pp. xiv + 534. (London: Chapman & Hall. 1939. Price 25s.)

This book is described by the author as "an attempt to gather together in a concise and ordered form, the result of all the relevant and reliable investigations on the chemistry of milk." It is an encyclopædic work of reference of particular value to scientists and research workers rather than to elementary dairy students, and constitutes a mine of appropriate factual information on the subject of milk from the physical and chemical standpoints. It is not possible in a short review to do justice to the volume, which covers a wide range of important data and includes special sections on nutritional aspects, and the chemistry of milk processing.

In the chapter dealing with the composition of milk, it is stated that "the results of a large number of experiments show that, where cows are suitably fed, the butter-fat content of milk cannot be altered appreciably by food, and that any effect on the content of solids-not-fat is still more difficult to trace."

According to Dr. Davies, the value of the freezing point determination as a means of differentiating genuine poor milk from milk to which water has been added, cannot be over-estimated: and it is of interest to note that cream has the same freezing point as normal milk. Condensed pasteurized whole milk, it appears, can be frozen without loss of body or flavour, and can be satisfactorily reconstituted after remaining 4 weeks in the frozen state.

This book fully justifies the author's claim for it, and it is really an indispensable addition to the library of all advanced students of scientific dairying, whatever may be their calibre or background.

The Plough-up Policy and Ley Farming. By Sir George Stapledon. Pp. 170. (London: Faber & Faber. 1939. Price 2s. 6d.)

No one can speak with a wider experience, greater authority or more enthusiasm on the subject of grass as a crop than Sir George Stapledon. Farmers will appreciate his effort in writing a book in which he describes the various methods of dealing with poor grass land to ensure the creation of fertility by ploughing out and re-seeding, the necessary manurial and cultural treatment, the varieties and strains of grasses; in fact, everything under all conditions concerned with the establishment and management of grass land whether short or long duration leys. This book is offered to farmers at a price within the reach of all, for Sir George recognizes that the "ploughing out" payment together with the lime and slag rebates is greater than a food emergency measure and will promote a higher state of land fertility of long duration. Farmers will appreciate the Government recognition of the importance of fertility, and all interested can be recommended to read the book.

Milk Investigation Scheme. Costs of Milk Production in England and Wales. Interim Report No. 3. October, 1936, to September, 1937. Pp. 48. (Oxford: Agricultural Economics Research Institute. 1939. Price 1s. 6d.)

This interim report contains the results of the third year's working. Most of the report deals with the cost of production on 437 farms selling milk mainly on wholesale contracts (wholesale group), but it also includes the figures of 64 producers of Grade A (T.T.) and Certified milk (graded group), and of 53 producer-retailers (producer-retailer group).

The costs of production of producers of graded milk and of producer-retailers were 1.88d. and 1.35d. per gal. higher respectively, than in the

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wholesale group. Certain features associated with different types of production were emphasized by the costs: for example, in the graded group labour was 2.55*d.* per gal. (wholesale 2.26*d.*), miscellaneous expenses were 1.72*d.* (wholesale 1.29*d.*) and herd replacement cost 1.22*d.* (wholesale 0.83*d.*); while in the producer-retailer group labour costs and miscellaneous expenses were 2.85*d.* and 1.57*d.* per gal. respectively.

In the wholesale group it was found that the cost of foods in the winter was 7.82*d.* per gal. compared with 4.46*d.* in the summer. The cost of labour over the year was 2.26*d.* per gal.; this cost in the winter was 2.52*d.*, which was $\frac{1}{2}$ *d.* more than in the summer. Family labour accounted for 0.51*d.* per gal., or 23 per cent. of the total cost of labour during the year. The other items, miscellaneous expenses and herd replacement, amounted to 1.29*d.* and 0.83*d.* per gal. respectively.

The changes in costs between 1935-6 and 1936-7 were examined by comparing the figures of farms of which records were available in both years. In all groups the net farm cost rose appreciably in 1936-7, from 9.04*d.* to 9.37*d.* in the wholesale, from 11.27*d.* to 11.77*d.* in the graded, and from 10.39*d.* to 10.59*d.* in the producer-retailer group. The increase was due mainly to a rise in food costs, although this was modified by a decline in all groups in the costs of herd replacement.

The report deals with a number of other factors affecting the cost of milk production, namely, the influence of production for level delivery and of accredited milk, the influence of size of herd, the effect of yield, and the costs on farms with and without milking machines.

Hardy Chrysanthemums. By Alex Cumming. Pp. xvi + 168. Illus. (New York and London: McGraw-Hill Publishing Co. 1939. Price 10s. 6*d.*)

This book deals with the hardy or garden chrysanthemum, and is written by the raiser of the recently introduced Korean Hybrids. It is essentially a practical book, and contains much of interest to the amateur, the chapters on history, general cultivation and breeding being particularly attractive.

There are of necessity slight differences between some of the American methods and our own, the most noticeable being in methods of propagation and winter treatment, while in the list of recommended varieties we miss some of our own special favourites.

More might have been said on diseases and pests. The increasing menace of eelworm is fully treated, but rust and chrysanthemum midge are dismissed in a few lines.

While the author is naturally enthusiastic over Koreans, he considers that the garden chrysanthemum is only "just on the way," and that there is still a wide future. No doubt Koreans will, like other plants, be superseded, but the expressed hope of very early varieties is likely to meet with but poor response in England. There are so many summer favourites, and the public does not want chrysanthemums all the year round.

Jahrbuch der Gesellschaft für Geschichte und Literatur der Landwirtschaft. (Year-Book of the Society for Agricultural History and Literature.) Heft 1/2. Pp. 32. (Göttingen. 1939. Annual subscription—3 parts—RM. 3.)

This book, which forms a part of a new series of pamphlets on agricultural history, is intended for the instruction of the German people in the historical development of the peasantry. The Society responsible for its publication is not concerned merely with agricultural history in general, but also with the development of agriculture and the peasantry in particular countries and districts. The Year-Book consists of articles

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on manners and customs, as well as of historical reports relating to the life of the countryside.

The present volume contains an article on the 200th Anniversary of Johannes Beckmann, who was a professor at the University of Göttingen from 1766 to 1811, in which the important work of this founder of agricultural science finds its due appreciation. There is also an article that explains the nature of the almost forgotten "Dutch dairy-farm," the precursor of the modern dairy-farm. Another article is devoted to the old East Prussian custom, fast falling into oblivion, of singing verses during the threshing-work, a custom much in vogue in the time of flail-threshing. The last article brings us to the 18th century and to the "Economic Counsels and Agricultural Observations" of the botanist Ehrhart, which have an almost modern application.

Diseases of Fruits and Hops. By H. Wormald. Pp. 290. Illus. (London: Crosby Lockwood. 1939. Price 17s. 6d.)

In recent years commercial fruit growers have shown an increasing interest in the work of horticultural research stations and an evident desire to become more acquainted with the nature and control of the various insect pests and diseases that do harm to their crops. Two years ago Dr. Massee, in his book *The Pests of Fruits and Hops* (see this JOURNAL, XLV, 1938, 198) dealt with the insect pests and now, in the present companion volume, Dr. Wormald provides growers and others with the information for recognizing and controlling the many fungus and allied diseases of fruits and hops.

After three chapters of introductory matter there are eleven chapters dealing with the symptoms and control of the various diseases affecting individual tree and soft fruits, grape vine, fig, mulberry, walnut, cob nut and hop. Under each host the diseases are grouped in sequence according to their occurrence on the roots, stems and branches, leaves, flowers or fruit, irrespective of whether the same disease affects more than one of these parts. The arrangement facilitates identification of the symptoms, but, owing to the confusion introduced by much necessary repetition and cross reference, its advantage over a straightforward account of the disease as a whole is a doubtful one. In Chapter XV a brief account is given of about a dozen important diseases not yet recorded in Britain, though the author has overlooked the fact that one of them—apple Blister Canker (*Nummularia discreta*)—was found in Yorkshire in 1910.

In addition to an author index there are indexes to the popular names of the diseases and the scientific names of the organisms causing them. The information given in the book is thoroughly reliable and up-to-date, and the volume is profusely illustrated with 130 beautiful photographs, mostly original, and a number of text figures. It should be of the greatest assistance, not only to commercial growers and gardeners, but also to students and horticultural advisers, as well as to plant pathologists generally.

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THE JOURNAL OF THE MINISTRY OF AGRICULTURE

VOL. XLVI

No. 6

SEPTEMBER 1939

Increasing the Demand for Milk

Negotiations with the Milk Marketing Board for the inauguration of the Scheme for increasing the demand for milk by supply at reduced prices to nursing and expectant mothers and children were brought to a successful conclusion by the submission by the Board on July 26 of a Scheme which was approved by the Minister of Agriculture and Fisheries the same day. The Exchequer contribution which will be payable to the Milk Marketing Board by the Ministry is calculated to cover the loss incurred by the Board in giving effect to the arrangements made. This loss has been assessed, for the period ending September 30, 1940, at the difference between the Board's return under the Scheme, which will be 8d. a gallon, and, on the average over the year, 1s. 2d. a gallon. The actual rate of grant will vary from month to month according to the seasonal variations in the regional price of milk.

The aim of the Scheme is to enable all expectant and nursing mothers and children under five, who cannot afford to buy the milk they need at the full retail price, to obtain a pint a day either free or for not more than 2d., according to their family circumstances. This aim it is hoped to achieve by making liquid milk available to local authorities for the purpose of their maternity and child welfare arrangements at 1s. 4d. a gallon, which is little more than half the ordinary price. Local Authorities already supply milk widely but it is anticipated that this reduction in price will make it possible for them to supply considerably more than has hitherto been possible.

The Scheme came into force on July 31, but before it can operate in any particular area the local authority concerned has to prepare proposals for the approval of the Minister of Health. Consequently, the success of the Scheme will depend, in the first instance, on the response made by local authorities

and thereafter on the response made by those entitled to participate. The arrangements made enable the milk to be delivered at the homes of those participating in the Scheme* by any dairyman who has previously been approved by the local authority as a supplier under the scheme.

Assistance to Barley Growers

SCHEME FOR BARLEY HARVESTED IN THE YEAR 1939

Part II of the Agricultural Development Act, 1939,† gives to the Ministers responsible for agriculture in England and Wales, Scotland and Northern Ireland power to make barley schemes which may be either based on the principle of the payment of a minimum price for a minimum quantity of home-grown barley by brewers, distillers and other users for malting purposes, or by the payment of a levy by such users of barley and contributions from the Exchequer to a central fund from which subsidy would be payable to growers on an acreage basis, the rates of levy and the amount of the Exchequer contribution being dependent upon the average prices realized for barley sold for malting and for feeding respectively.

There has been insufficient time to prepare and bring into operation by the beginning of the 1939 barley season a comprehensive long-term scheme on either basis, and in accordance with the provisions of Section 20 of the Act, a temporary simplified scheme‡ embodying the principle of a levy has been made and approved by Parliament for the 1939 crop only.

Under this scheme a Barley Subsidy Fund is to be established under the control of the Ministers concerned with agriculture in the United Kingdom. Into the fund will be paid the proceeds of a levy upon brewers and importers of beer, and from such manufacturers of pot still whisky as do not qualify for exemption under the conditions laid down in the scheme. The rate of levy will be determined on a sliding scale in accordance with the weighted average price of barley during the six months ending on January 31, 1940, as determined

* Scheme for increasing the Demand for Milk in England and Wales by its Supply at Reduced Prices to Nursing and Expectant Mothers and Children under five years of age. Copies obtainable from H.M. Stationery Office, York House, Kingsway, London, W.C.2, or through any bookseller, price 1d. net.

† The main provisions of the Act, which received Royal Assent on July 28, 1939, were summarized in the July, 1939, issue of this JOURNAL.

‡ Published by H.M. Stationery Office, price 3d. net.

from the returns obtained under the Corn Returns Act, 1882, and will vary from 1*d.* to 1*s.* per standard barrel of beer and from 1*d.* to 4*d.* per proof gallon of whisky according as the average price of barley varies between 9*s.* 11*d.* and 8*s.* 1*d.* per cwt. The levy will be charged upon each manufacturer's output of beer or whisky and upon each barrel of beer imported, subject to certain rebates and repayments.

Manufacturers of pot still whisky will be allowed to claim exemption from payment of levy under certain conditions set out in the scheme. These include the payment of a minimum price of 8*s.* per cwt. for home-grown barley and the purchase of a minimum quantity of 50 per cent. of home-grown barley in the total quantity of materials used.

Out of the fund a subsidy will be paid to growers on the basis of their acreage under barley for harvest in 1939, the rate of subsidy payment also being on a sliding scale dependent upon the average price realized for barley during the period above mentioned and varying from 2*s.* 6*d.* to a maximum of 30*s.* per acre. Provision is made in the scheme for the reduction of subsidy payments in respect of that part of any farmer's crop of barley which has been sold at or above the minimum price for the production of pot still whisky by a distiller who has claimed exemption from the scheme.

The difference between the total sum contributed to the fund by manufacturers and importers, and the amount that is required to make the subsidy payments indicated above, will be met by a contribution from the Exchequer.

Farmers will be required to make application for subsidy payments and forms of application will be issued early in September to all growers whose annual agricultural returns showed that they grew barley during the current season. These forms must be returned in the case of farmers in England and Wales to the Ministry of Agriculture and Fisheries, 80, Leonard Street, London, E.C.2, on or before September 30 next. Any grower of barley who does not receive a form by September 15 should write to the Ministry at that address. Barley grown mixed with other crops (except seeds) will not be eligible for subsidy under this scheme, but will be eligible for subsidy at the rate appropriate for oats, for which separate provision is made in Part I of the Act.

HOP DRYING

140°F. during the first three hours of drying, after which it could be kept constant, or be allowed to rise slightly, but should never exceed 160°F. This advice still affords safe general guidance to the hop dryer with regard to temperatures. The use of thermometers was advocated but, as in the time of William Ellis, the majority of dryers continued "to trust to their skill" and, in the general absence of forced draught and the practically infinite variation in the behaviour of kilns in respect of natural draught, hop drying still remained rather more of an art than a science. The specification of drying temperatures led to the production, during the first two decades of the present century, of thermometers specially designed for use in hop kilns, but owing to various causes they did not come into very general use.

In 1920, the Institute of Brewing inaugurated a Research Scheme; this included provision for investigations into the process of hop drying. An experimental oast, designed by the writer, who was put in charge of the investigations, was erected at Paddock Wood by the Institute in 1921.* This comprised four small kilns fitted with pure air heaters, in each of which the temperature, draught and other factors affecting drying could be kept under exact control. The results obtained in these investigations have largely increased our knowledge of the subject and have made it possible to standardize the process.

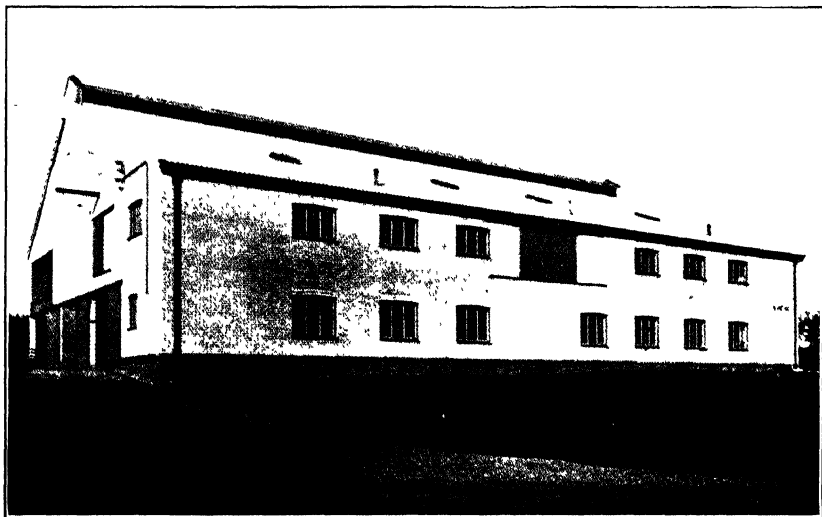
The experiments have shown that the rate of drying depends upon the air speed (draught), temperature and humidity of the air, depth of loading and, to a much less extent, upon the variety and condition of the hops, such as ripeness and wetness with rain or dew. The amount of sulphur burned does not affect the rate of drying. By drying series of loads of different depths, under otherwise identical conditions, it has been found that even the shallowest load possible requires a considerable time to dry which, under the conditions obtaining in good commercial drying, is about five hours; this has been named the "Minimum Time." The length of the Minimum Time varies considerably with variations of temperature, the higher the temperature the shorter will be the Minimum Time, but it is affected in only a comparatively small degree by variations in draught. As the depth of loading is increased, so the time of drying increases above the Minimum Time. This increase in time of drying due to depth of loading has been named the "Extra Time"; this Extra Time added to the Minimum Time

* For these references see p 521.



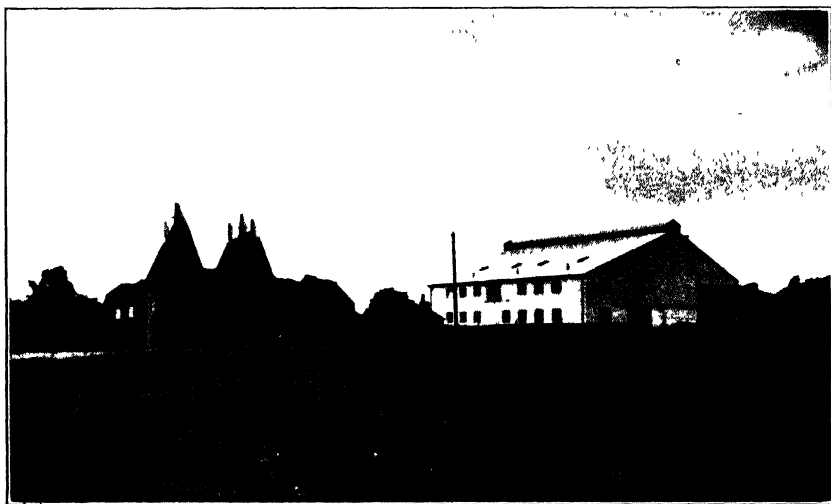
Oast house with six round kilns fitted with wooden cowl

(Photo by courtesy of Messrs Drake & Fletcher)



Oast house of modern construction. Square kilns are incorporated within the building these are fitted with louvres instead of cowls. Forced draught is supplied by electric fans.

(Photo by courtesy of Messrs. Drake & Fletcher.)



Oast houses. The modern oast house (right) has replaced the old oast house (left).

(Photo by courtesy of Mr. P. Henley.)

HOP DRYING

make up the Total Time of Drying. The Extra Time depends upon temperature to the same extent as the Minimum Time; it is, however, inversely proportional to the speed of the draught and increases in direct proportion to the depth of loading; e.g., if, under certain conditions, the Minimum Time is 300 minutes and the Total Time required to dry a load 6 inches deep is 390 ($=300+90$) minutes, then the Total Time required to dry a load 12 inches deep would be 480 ($=300+180$) minutes.²

The rate of drying increases rapidly as the temperature of the drying air is increased but, on the other hand, the commercial value of hops can be greatly reduced by the employment of too high a temperature, which adversely affects the appearance, aroma and preservative value of the product. If hops are allowed to become warm while they are in a moist condition they acquire a dull appearance, and, as this reduces their market value, it must be avoided as far as possible by the employment of a comparatively low temperature during the early stages of drying. The actual temperature at which drying may safely be commenced depends upon the strength of draught in the kiln; with slow draughts, such as are found in natural draught kilns, the commencing temperature should not be above about 90°F. , but with a quick draught produced by a fan it is possible, provided that the hops are not loaded too deeply, to commence drying at a temperature as high as 120°F. without detriment to the brightness of the hops.³ When moisture evaporates from the hops it cools them to a certain extent, and with a quick draught the rate of evaporation is increased; this renders it possible to employ the higher temperature without unduly warming the moist hops.

Under no circumstances should water vapour, produced from the lower hops of the load, be allowed to condense upon hops in the upper parts of the load; if this occurs, heat is transmitted from the vapour to the hops, which causes them to assume a dull appearance. Conditions which lead to such a condensation of moisture are high commencing temperature, slow draught and deep loading. Both the maximum safe commencing temperature and the maximum safe depth of loading are dependent upon the draught in the kiln, and if either of these is exceeded condensation will occur.

Sulphur, in the form of roll brimstone, is burned below the hops during drying to produce the even yellowish-green colour esteemed on the market, and also to prevent the hops from developing an aroma somewhat resembling dried foliage leaves.

HOP DRYING

The effect of this sulphuring is greatest when the hops contain their full amount of moisture, and gradually decreases as they become dry; the sulphur should, therefore, be burned as soon as the hops are loaded, otherwise the hops, particularly those in the lower part of the load, are not satisfactorily treated. The sulphur dioxide gas, which is produced by burning sulphur, mixes with the air which passes through the kiln and, to bring about the desired modification in colour of the hops, it is necessary to ensure that the mixture is sufficiently rich in sulphur dioxide: in other words, the amount of sulphur burned must be proportional to the strength of the draught through the kiln. A concentration of 1 oz. of sulphur dioxide (produced from $\frac{1}{2}$ oz. sulphur) per thousand cubic feet of air passing through the kiln during the first hour of drying gives, with ripe hops, the best results.

The temperature of the drying air is raised gradually at the rate of about 10°F. per hour to the maximum temperature, at which it is maintained constant. The temperature of the air in a hop kiln is now generally measured by means of a long stemmed transmitting thermometer, which is very satisfactory for the purpose; the bulb is fitted about 6 in. below the drying floor and protected from radiant heat; the dial of the thermometer, or recording apparatus, is fixed at a point which can be seen from the place of temperature control. The question as to what shall be the maximum degree to which the temperature is raised depends upon various considerations, the most important of which is the fact that the higher the maximum temperature of drying the lower will be the commercial value of the dried hops. The values ascribed to aroma, preservative value and appearance all decrease as the maximum temperature employed increases, although it has actually been found by brewing experiments that hops dried at a maximum temperature of about 150°F. produce the best flavoured beer. The deterioration in colour value caused by a high maximum temperature of drying is distinct from the dullness caused by heating when the hops are in a moist condition; a high maximum temperature produces a slight browning of the cones, of the nature of scorching or toasting, the degree to which it develops being determined by the height to which the temperature is raised. At temperatures above about 160°F. the coloration becomes distinct and, in good drying practice, this temperature is never exceeded. Bearing these facts in mind, the dryer will endeavour to keep the temperature as low as

HOP DRYING

possible and thus secure the highest price for the hops; but the lower the temperature the longer will the hops take to dry and, as it is usually necessary to load the kiln twice in twenty-four hours in order to keep pace with the picking, it is rarely possible to get the drying done at a maximum temperature lower than about 140°F., the more usual maximum being 150—155°F. Each load should take about 10½ hours to dry; this allows an hour and a half for unloading and reloading the kiln. Where there is abundant kiln space it is unnecessary to dry two loads per day; it is then possible to use a lower maximum temperature with advantage to the commercial value of the hops.

Heating by means of closed stoves has now largely displaced the older system of open anthracite fires. Temperature control is, generally speaking, easier with closed stoves and, of course, the products of combustion are not present in the air which passes through the hops; provided, however, that the strength of draught, amount of sulphur burned and temperature are the same, there is no difference in the appearance, aroma or preservative value of hops dried with either form of heating.^{5, 6}

There is at present no satisfactory means for determining when a load of hops is sufficiently dried; this is left to the personal judgment of the dryer. The average moisture content of the load should be about 6 per cent. at the end of drying; the "strig," or axis, of an individual cone containing this amount of moisture feels quite dry but is not brittle; it somewhat resembles a piece of dry string. The moisture is, however, not evenly distributed throughout the load; the lower hops are drier than the upper hops, and the slower the draught the greater will this difference be at the end of drying; the dryer must make allowance for this in deciding when the hops are in a fit state for unloading. If hops are overdried, they become very brittle and harsh to the touch and they will never, even after reabsorption of moisture, quite regain the soft silky texture which is appreciated on the market; on the other hand, if hops are packed in an underdried state they will deteriorate rapidly in storage and must be redried or sold for immediate use, either of which entails a considerable reduction in their commercial value.

Freshly dried hops are very fragile and, as whole hops are worth more than broken hops, great care must be taken in unloading from the kiln. Cool air should be allowed to pass through the load for a short time before its removal from the

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kiln; the bracts ("petals") of the cones, which are very dry and easily broken, absorb from the air a small quantity of moisture which toughens them slightly, but the cool air must not be passed for too long or the total moisture content will rise too high. To assist in removing dried hops from the kiln with a minimum of breakage, devices such as "roller floors," which carry the hops from the kiln to the cooling-room, or "lifter cloths," on which the hops can be lifted from the kiln without disturbance, are frequently employed.

As has been mentioned above, the moisture in freshly dried hops is not evenly distributed among the cones; further, the moisture remaining in each individual hop cone is also unevenly distributed, the "strig" containing more moisture than the bracts. The bracts when dry are very easily detached from the "strig," but if the residual moisture in the "strig" is allowed to diffuse into the bracts they become toughened and more securely attached to the "strig." After removal from the kiln the dried hops are placed in a heap in the cooling room for some hours, in order that this levelling up of moisture may take place; there is also a redistribution of moisture between the moister and drier cones. This toughens the hops so that they can be pressed into the "pockets," in which they are marketed, without excessive breakage. Dried hops absorb moisture very readily and, for this reason, the heap of hops should be made deep, so as to expose as small a surface as possible to the atmosphere. The heap should be covered with a cloth to prevent absorption of moisture by the outer layers of hops, and there should be no cracks or holes in the floor below the heap through which air can rise and pass through the hops. Such a heap of hops should be allowed to remain as long as possible before packing (it could be left for two weeks without detriment to the market value of the hops), but it is generally necessary to press the hops into pockets within a few hours to make room for another load. At the time of packing, if the hops have been correctly dried, the moisture content will have risen slightly; during storage it will continue to rise until equilibrium is established between the moisture in the atmosphere and that in the hops. This equilibrium moisture content depends upon the relative humidity of the atmosphere and, under the usual conditions of storage, is generally between 10 and 12 per cent. The object in reducing the moisture content to about 6 per cent. on the kiln is to get the "strigs" into a sufficiently dry condition and to allow for absorption of

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moisture by the dry bracts, which are very hygroscopic, during cooling and packing.

From the point of view of thermal efficiency the system of hop drying practised in this country leaves much to be desired. If the air leaving the kiln becomes laden with moisture beyond its point of saturation the value of the hops will suffer; nevertheless, under normal drying conditions the air absorbs moisture to a reasonable concentration during the first hour or two of drying. As the process continues the relative humidity of the air emerging from the hops rapidly decreases and, during the last three or four hours of drying, the heated air absorbs very little moisture and still retains the greater part of its drying power after leaving the hops.⁷ The "strig" is the last part of the cone to become dry and a large proportion of its moisture is removed by diffusion into the bracts and thence by evaporation; the bracts when nearly dry are hygroscopic, and, in order to remove moisture from them, air of low relative humidity is necessary. It is this necessity which entails the waste of heated air.

A greater thermal efficiency can be achieved by the use of multiple floored kilns, such as are commonly used on the Continent,⁸ in which the hops on the upper floors are partly dried by the hot air which has passed through the nearly dry hops on the lowest floor; but, as has been mentioned before, sulphuring presents a difficulty with this type of kiln. Another method of reducing the loss of heat is by increasing the depth of loading, when the hops are partially dry, with additional partially dried hops from another kiln.⁹

In order to effect the greatest economy of heat it would be necessary to devise a kiln through which a continuous stream of hops would pass, becoming dried during transit; the temperature and speed of air and rate of movement of the hops being adjusted so that the exhaust air would be in a nearly saturated condition. Hop kilns are, however, used for only about three weeks in each year; any new type of kiln to be economical should, therefore, not involve too high a capital expenditure on construction, otherwise the greater thermal efficiency might be more than counterbalanced by expenditure.

REFERENCES. All are to the *Journal of the Institute of Brewing*, as follows:

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| (1) Vol 28 (1922), 4, 291 | (6) Vol. 33 (1927), 2, 61 |
| (2) .. 43 (1937), 8, 329. | (7) .. 35 (1929), 5, 243. |
| (3) .. 45 (1939), 9 (Sept.) | (8) .. 38 (1932), 5, 226 |
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SYSTEMS OF SHEEP FARMING : I. MOUNTAIN SHEEP

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Introductory. Sheep farming is one of the most distinctive features of British agriculture, and the number of sheep in proportion to the total land area is much higher than in any other country except New Zealand. This is mainly due to the great preponderance of grass and to the comparatively mild, equable climate which allows some growth of herbage almost throughout the year. The greater part of our breeding stocks are kept on grass land—including mountain grazings and hill pastures—and with the approach of autumn numbers are reduced either by the sale of fat lambs for slaughter or by the transference of store lambs to arable land for winter fattening. Thus to a great extent numbers are adjusted to the seasonal growth of grass and heavy expense on winter feeding of the ewe flock is avoided. It was shown in the table given in the first article of this series (p. 129, May, 1939) that sheep now contribute less to the farmer's income than some other branches of farming generally regarded as of less importance. For instance, in 1936 the total value of sheep, lambs and wool sold off the land in Great Britain was £23,430,000, whilst poultry and eggs sold off farms gave a return of more than £25,000,000, but it must be remembered that the return from sheep is nearly all the product of our own soil. Poultry, pigs and dairy cows are fed to a considerable extent on concentrated foods largely imported from overseas. Moreover, a large part of our sheep flock is kept on poor upland, which under present conditions cannot be profitably used to any considerable extent for other kinds of stock. From the farmer's point of view sheep have the further advantage that when kept on grass land they require very little expenditure on labour.

The fact that we have about thirty distinct breeds of sheep with very varied systems of management indicates the extent to which specialization has been carried, largely to meet local variations in soil and climate, but the great majority of our sheep can roughly be divided into three large groups.

- (a) Mountain or hill flocks whose chief products are store lambs and draft ewes.

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- (b) Flocks kept largely or entirely on arable land. Formerly these supplied large numbers of fat lambs and tegs to the ordinary market, but now their most important role is the production of rams of first-rate mutton quality for crossing purposes.
- (c) Lowland grass flocks, usually of a temporary type, kept chiefly for the production of fat lambs and consisting mainly of draft ewes from the upland flocks mated with rams from the arable flocks.

In all groups wool is an additional source of revenue. In the Middle Ages and up to the 18th century it was the main object for which sheep were kept, but since the 18th century it has been quite subsidiary to meat in all our British breeds.

Mountain Sheep Farming. The above classification of British sheep indicates that the mountain flocks are not only of importance in themselves, but that they also serve as a source from which the lowland grass flocks are renewed each autumn. In the report published in connexion with the Census of Production taken in 1908, an estimate was made of the numbers of different breeds of sheep in Great Britain. Out of the total sheep population of 27 millions, the following were the figures for the chief mountain breeds:—

Black-faced Mountain and "Scotch"	..	6.7	million
Cheviot	.. .. .	2.6	..
Welsh Mountain	.. .. .	2.6	..
Herdwick	.. . . .	.5	..

Adding the smaller numbers for hill breeds, such as the Kerry Hill, Exmoor, Clun and Lonks, it was thus estimated that at that time half the total sheep population belonged to these mountain and hill breeds. The estimate has been little more than a very rough approximation, but it serves to show sufficiently well the position of mountain sheep. Since then, there can be no doubt that their relative importance has greatly increased. Consumers nowadays require small joints with comparatively little fat, and farmers require hardy sheep which can be maintained cheaply on grass with little expenditure on labour or purchased feeding stuffs. The first fact has resulted in an immense reduction in the number of large, long-woolled sheep, and the second has similarly affected the number of the Down sheep associated with arable farming.

Another important point is that the production of fat lambs has become the most important branch of lowland sheep farming. For this purpose, the mountain ewe or a cross from a mountain ewe, is well suited, largely because of her superior milk production and excellent mothering qualities.

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It is hardly necessary to attempt to define exactly what is meant by mountain sheep farming. It is common knowledge that in the Scottish Highlands, the N. of England and in Wales, there are large areas of rough land ranging from sea level to over 3,000 ft. (but most of it between the 500 ft. and 2,000 ft. contours) and covered with very varied types of vegetation. Perhaps the most extensive of these are the heather moors, which, wherever they occur, nearly always carry sheep of the Blackface mountain type. For other sheep, the most highly valued is the bent (*agrostis*) and fescue combination which occurs on fairly good, well-drained slopes, but other plants, including cotton grass, *molinia* (flying bent), *nardus* (mat grass) and rushes, occur very extensively, often interspersed with other main types, and contributing their quota to the food supply at special seasons of the year. Very little of the land associated with mountain sheep farming has ever been cultivated, though when new large grazings have been created—as, for instance, in the Scottish Highlands at the end of the 18th century—they often include patches in the valleys where cultivation was formerly practised.

Where cattle are kept on hill pastures, they are usually store cattle secured for the summer grazing only, or cows of a hardy breed such as the Galloways or West Highlands. Until a few years ago, the grazing of store cattle on the lower hill pastures was practised to a considerable extent. The cattle when sold in autumn generally left a small margin to cover expenses, and, in addition, benefited the grazing by clearing the rough growth and thus improving the quality of the herbage in the following spring. Stores are now so dear in spring and so cheap in autumn that they have to be sold for less than their cost price, and the practice is only followed to a very limited extent. Mountain ponies have also generally declined in numbers owing to the adoption of mechanical haulage in coal pits. In the main, therefore, sheep are relied upon almost entirely for the grazing of mountain land.

The type of sheep and management vary considerably with the elevation and quality of the grazing. The highest ground and the poorest land will only carry pure mountain breeds, but on lower ground a proportion of the ewes may be crossed with some lowland breed for the production of cross-bred store lambs. In Scotland the Border Leicester is almost universally used for this purpose. In the north of England the Wensleydale is perhaps the favourite, whilst in Wales, where the

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practice is much less common, the Kerry Hill is generally employed. On still better land, cross-breds may be maintained entirely. Considerations of space make it necessary to concentrate attention on the most important of these types, and, therefore, the following observations will refer in the main to the pure mountain flocks kept on high or very poor land.

Quite as important as the poverty of the soils or the deficiencies of the herbage of mountain land is the fact that at high altitudes the growing season is short, and this accounts for the chief fundamental difficulty in mountain sheep farming.

On lowland it is possible to adjust food supply to the numbers of stock by purchases and sales of one or both as required. Moreover summer grass can be preserved in the form of hay or silage for winter use. Very little conservation of grass is attempted on upland and, as will be seen later, the mountain flock must be of a permanent character. Thus if the area of mountain to available lowland is high, it may be quite impossible to stock the high land fully during its short summer season, because of the difficulty and expense of carrying the sheep through the rest of the year. In extreme cases it may not be economic to stock the land with sheep at all, and this is one of the reasons for the existence of deer forests in the Highlands. Elsewhere, the proportion of high mountain land is not so great and on the lower slopes there are areas on which sheep can be wintered, though very commonly—perhaps in the majority of instances—mountain farmers have to send their ewe lambs, and often some of their ewes, to more or less distant farms for the winter. This cost of wintering is usually one of the biggest items of expense in the farmer's accounts and is often considerably greater than his rent.

It has already been stated that a mountain flock must be a permanent one—permanent not only in the sense of being self-supporting for a number of years but also permanent in that it is maintained more or less intact during changes of tenancy. Consideration of the reasons for this will incidentally show other ways in which mountain sheep farming differs from lowland practice: (1) On a lowland farm, food and environment can be adjusted to a great extent to suit the size and type of sheep it is desired to keep. On a mountain farm the sheep must be adapted to suit the grazing and local conditions. In securing this adaptation, natural selection plays a large part. Under bad management the effect is often direct and immediate. Under good management it is very largely indirect, as

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the skilled flockmaster draws on his experience and observation in his breeding policy. As far as possible he avoids introducing rams likely to beget stock unsuited to his particular grazing, and he soon gets rid of those whose progeny are unsatisfactory. Hardiness in mountain sheep is a complex of characters including activity, protection against unfavourable weather and many other essentials, but quite as important as any is the adjustment of size and rate of growth to the food supply of the grazing on which the sheep have to find their living. (2) Many mountain grazings are unenclosed. The boundary may simply be a small stream or watershed or some similar natural feature, which, though not marked by a fence, is known and respected by sheep reared in flocks which have been grazed on their respective sides for generations. If these flocks were dispersed and replaced by sheep from another district, the difficulty of shepherding for some years would be enormous. (3) On such unenclosed ground, often grazed as common land, particularly in Wales and the north of England, the sheep have to fend for themselves to a great extent. Knowledge of the grazing accumulated through many generations by the flock is necessary if the sheep are to take full advantage of shelter in bad weather, and of differences in the food supply on different parts of the mountain at various seasons of the year. (4) Certain diseases on unhealthy grazings play havoc with imported sheep, but animals reared on the land appear to become more or less immunised in early life.

The ways by which the permanence of the flock is secured vary considerably. For instance, in a few Herdwick flocks in the north of England the flock is the property of the landlord, and the tenant simply has the use of it during his tenancy. When leaving the farm he is required to hand over a fixed number of the different ages and kinds of sheep. The usual arrangement which prevails throughout the greater part of Scotland, and is also common in the north of England and in some parts of Wales, is for the tenant to take over the sheep from the outgoing tenant at a valuation. In making this valuation it is customary to add to the market value a sum in recognition of the fact that the sheep are worth more to that particular grazing than to any other. In England and Wales, the amount so added is usually quite small, often 2 or 3 shillings a head. In Scotland, the practice has developed of assigning to this "acclimatization value" very considerable amounts. This

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has unfortunate results. Even if the tenant is sure of obtaining the same acclimatization value when he leaves the farm, the practice greatly increases the amount of capital required to take the farm, and thus accentuates one of the chief drawbacks of mountain sheep farming, namely the high capital outlay compared with the annual turnover. This is often said to be one of the fundamental differences between farming and most other businesses, but probably in no branch of farming is it so important as in mountain sheep farming. In a time of high prices it adds to the difficulty of securing suitable tenants, and in the Highlands is another of the factors responsible for the existence of deer forests.

In addition to the risk involved in laying out a large amount of capital in an industry where the annual turnover is small and fluctuations in prices are considerable, there is also the risk of disastrous losses from snowstorms and disease. On the other hand, the annual outgoings are comparatively small. With assistance at lambing, dipping, shearing, etc., a shepherd can usually look after a flock of 600 breeding ewes. Expenditure on feeding stuffs, manures, seeds and similar items is very low, and even the rent as a rule is not very burdensome. Interest on capital—if borrowed—and cost of wintering are the chief items which usually give the farmer the greatest cause for anxiety. His ability to meet these depends on his crop of lambs, and there is great variation in this respect, not only from season to season, but from grazing to grazing. In a true mountain flock the percentage of lambs rarely reaches 100, and may be as low as 40 or 50, though probably 70 or 80 would be about the average. As only half of these are ewe lambs, it generally happens that ewes must be kept until they have had at least three crops of lambs if numbers are to be maintained. In Wales, ewes are generally drafted out when they have achieved this, so that the majority are sold at four years old. This has the effect of making it necessary to keep practically all the ewe lambs, so that little improvement by selection on the female side of the flock is possible. In Scotland, ewes are more often sold at five years old, so that the ewe lambs can be "culled" and there is a surplus which comes into the sales in the autumn.

The management of a mountain flock is to a great extent determined by factors such as the nature of the grazing and climate, outside the control of the farmer though very often something might be done by enclosing and improving lower

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parts of the hills. The sheep—unlike those in a lowland flock—have to depend largely on their own instincts and exertions for finding their food, and even for their survival. Thus, it is necessary to avoid changes of management—including supplementary feeding—which might seriously affect individual initiative.

There has, however, been a big change in the composition of the flocks, which formerly included wethers kept to the age of three or four years. These formed an important part of the hill stocks in Wales until 10 or 15 years ago. In Scotland, they had practically disappeared some years previously. There is now little or no demand for wether mutton which, when well hung and properly cooked, used to be regarded as a great delicacy. The low price of wool is another factor of considerable importance. The result is that mountain flocks now consist almost entirely of ewes and young lambs.

This replacement of wethers by ewes has resulted in deterioration of the grazings, first because the wethers could stand more severe conditions than breeding ewes, and—like mountain ponies—used to graze a lot of rough herbage in winter, which is now hardly ever touched; second because the replacement of wethers by breeding ewes involves a greater drain on the mineral resources of the soil. At the same time, the increase in the ewe stocks has enabled the mountain farmer to meet the demand for draft ewes suitable for fat lamb production, which, as will be seen in a later article, has greatly increased in importance.

An article on mountain sheep farming would be incomplete without a tribute to the shepherds and their dogs, on whom the success of the system so largely depends. In all systems of flock management a great deal has to be left to the judgment and initiative of the shepherd, but in none must the trust be so great as in the case of a mountain flock. It will be generally agreed that few classes of men rise more fully to the responsibilities of their position or carry out their work with greater skill and devotion.

EARLY OUTDOOR LETTUCES FROM PLANTS RAISED IN COLD FRAMES

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Lettuces matured out of doors and marketed in May and June may be considered one of the most desirable crops grown on intensive market gardens in the south of England.

Seedlings may be raised in heated glasshouses or frames, or in cold frames. The use of cold frames for this purpose will be described in this article, since many growers have no facilities for raising plants in heat. In cold frames, seed should be sown in late autumn, but where existing heated glasshouses are available, the seed need not be sown until early January, though the resultant crop may not be so satisfactory.

Two methods are practised using cold frames :---

(a) Seedlings raised and pricked out when small.

(b) Seedlings raised from thin sowings but not pricked out.

The method adopted will depend to some extent upon the facilities available, particularly regarding labour supplies. It is generally found that plants raised by method (a) (i.e., pricked out) are sturdier and possess a better root system than those not pricked out. Further, they are fit to transplant into the open ground earlier and normally mature earlier than those raised by method (b). On the other hand it should be pointed out that pricked-out seedlings obviously involve more labour.

Growers who depend upon thin sowings in frames to produce the bulk of the lettuce plants required often raise a few pricked-out seedlings and plant these in drifts across the lettuce field, so that these may be cut and marketed first and thus provide roadways for dealing with the bulk of the crop. Alternatively, these areas may be sown with radish soon after the lettuces are planted out.

There is little doubt that the Dutch pattern light is the best type for raising the seedlings, particularly those pricked out, since it allows a maximum possible amount of daylight to fall on to the young seedlings. Precautions should be taken to

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prevent drip occurring between the lights. The Dutch light is now widely used in horticulture and consists of a single pane of 21 oz. glass measuring 56 by 28 $\frac{3}{4}$ in. held in a light wooden framework, the outside measurements of which are approximately 59 by 31 $\frac{1}{4}$ in. (150 by 80 cm.). When English or French lights have to be used, satisfactory results can be obtained providing they are in good repair, free from leaks causing drip, and that the glass is well cleaned. These lights are often preferred to the Dutch pattern for raising the seedlings under method (b).

Seedlings Raised and Pricked Out when Small. Seed may be sown in shallow boxes placed in frames and later transplanted to frame beds or to other boxes, but on a large scale, direct sowing and pricking-out into frame beds is the rule.

Successive sowings are made in cold frames on raised beds from about October 10 to October 20 at intervals of 5-7 days and later transplanted to other frames, beginning as soon as the cotyledon or seed leaves are developed. The soil in the frames should be of a light nature, in good heart, and well prepared by raking, etc., so as to produce a good fine tilth. Land which has been well manured for previous crops should contain sufficient humus, but, if deficient, moist peat-moss may be incorporated when preparing the soil. Soils should be sufficiently moist to carry the crop over the winter months without recourse to watering. Thus, while a light soil is desirable, ample humus must be present to assist water retention and to permit healthy growth. Early digging or ploughing of the land so that the rains may be absorbed and conserved in the sub-soil are important factors. A light dusting of hydrated lime may be added to keep the soil "sweet." In certain seasons it is advisable to place the lights on the frames a week or so before sowing in order that the temperature of the soil may be raised, and to ensure that it is not too wet at sowing time.

Thin sowing is essential whether in seed trays placed in frames or directly in the frame beds. About $\frac{1}{4}$ - $\frac{1}{2}$ oz. seed is sufficient to sow one Dutch light. It is generally reckoned that 1 $\frac{1}{2}$ lb. of seed provides ample seedlings to plant out one acre of ground. After sowing, the seed is just covered with fine light soil which may be sifted directly on to the seed. Lights are placed on the frame and kept closed and (if necessary)

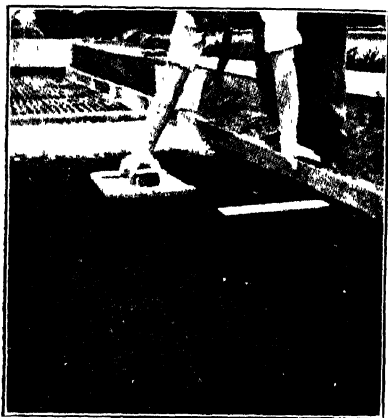


FIG. 1. Preparing frame beds for pricking out lettuce seedlings in their winter quarters (Method (b)). Note wooden marker halfway up the frame.



FIG. 2. Pricking out young lettuce seedlings.

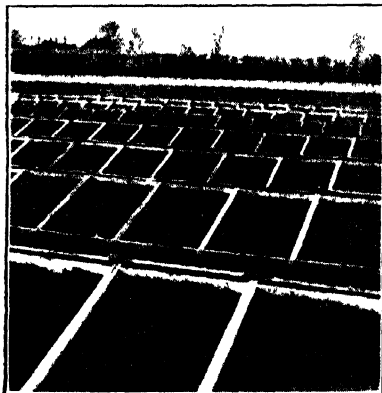


FIG. 3. Lettuce seedlings, sown thinly and not pricked out, overwintering in the frames. Note steep angle at which the frames tilt towards the south (Method (a)).



FIG. 4. Transplanting lettuce plants out of doors in early spring. Lines may be marked out with a 't' racer, or drill for cos lettuces, but a garden line is preferable for the cabbage type.

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shaded until the germination or "chitting" begins. Subsequently, ventilation is given in gradually increasing amounts, the lights eventually being removed entirely on warm, sunny days.

PRICKING OUT SEEDLINGS. As soon as the young seedlings have developed their cotyledon or seed leaves, transplanting or pricking out into other frames begins. The site for these frames should be prepared as early as possible, as indicated previously, and it is an advantage if preceding crops are such that the land is left as free from weeds as possible. Land which has produced leeks followed by three or four crops of radishes is suitable. It is an advantage if the raised beds for these frames are constructed so as to tilt towards the south, the rows of frames running from east to west.

The sides of the frames should be well banked with soil from the pathways between, so as to assist retention of warmth and moisture. The soil should fill the frames to within about 3 or 4 in. at the front (bottom) of the light and 6 or 7 in. at the back. It should be well prepared as previously indicated, and a dressing of moist peat moss is advantageous. Artificial manures must be used with caution, for while on some soils a dressing of $\frac{1}{2}$ oz. per square yard of sulphate of ammonia is beneficial, any excess of nitrogen will lead to soft growth and unsuitable plants. The general dressing recommended is a mixture of 2 parts of bone flour with 1 part of sulphate of potash, applied at the rate about $1\frac{1}{2}$ oz. per square yard.

The surface should be lightly dusted with hydrated lime and moderately firmed with wooden pressers, the usual size of which is 18 by 12 in. A marker consisting of a strip of batten wood to fit between the back and front boards of the frame, and having 2 in. nails protruding at a distance of 2 in. apart, is very useful. The marker is drawn along the frame, thus scratching lines 2 in. apart in the soil (Fig. 1).

The seedlings are very carefully lifted from the seed boxes or frames, avoiding damage to the roots, stems or leaves, and rejecting diseased plants. Particular notice should be taken of any plants which show brownish lesions on the seed leaf or stem, as these may be affected by the fungus disease called Botrytis.

The seedlings are pricked-out carefully, 2 in. by 2 in. apart, using a blunt-pointed dibber or the forefinger (Fig. 2). Care should be taken that the roots are well firmed and that the young seedling just "sits" on the soil at the correct depth,

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with the cotyledon just about the soil level. Seedlings should not be watered in, and when soil dryness is suspected, the soil in the frames should be watered a few days previously. The lights are placed on and kept closed until the seedlings recover from the check of transplanting. Subsequently ventilation is given in increasing amounts on all favourable occasions. No rain or snow, or even moisture from heavy fogs, must be allowed to fall on the plants. In severe frosts or when very cold winds prevail, some protection, such as mats or straw, may be necessary. The object is to grow the plants as hardily as possible without incurring risks from bad weather. Ventilation early in the morning after severe frosts, before the sun shines on the lights, will often prevent damage, since a rapid thaw is thus avoided. Throughout the winter a careful watch must be maintained for diseases and pests and the frames kept as free from weeds as possible.

Seedlings Raised from Thin Sowings but not Pricked Out. This method is said to have originated from intensive methods practised by the Huguenots, who settled in Middlesex as refugees in 1685.

The preparation of the soil and the erection of frames must be carried out in time for sowings to be made in October. The soil type and preparation is similar to that described in the first method. Phosphates and potash are usually added to encourage root action and sturdy growth, but excess of nitrogen must be particularly avoided. The frames are erected on beds which are raised with very steep slopes towards the south (Fig. 3). English lights are shown in use in Fig. 3, but Dutch lights may be used providing extra care is taken to secure the lights against gales. The back or north side of the frame is erected on a raised bank so that its base is about $1\frac{1}{2}$ ft. above the pathway, the front board being also raised so that its base is about 9 in. from the general level of the ground. The bed inside the frame should be made to slope accordingly and thus perfect drainage and the greatest utilization of the winter sunshine should be obtained. Such raised beds are particularly advantageous on land that tends to become excessively wet occasionally. Pegs are driven into the ground at the bottom of the frames to prevent the lights from sliding off the frames (see Fig 3). Space should be left between the ranges of frames so that the lights may be pulled off when full ventilation

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is given. These pathways between the ranges should have a gradual fall in one direction so that surplus water may be disposed of readily.

The preparation of the surface soil is particularly important. Wooden rakes are used, followed by iron rakes. Strips of wood about 12 in. long by 3 in. wide are used finally to level the soil, care being taken not to roll the soil into small lumps, as a lumpy tilth appears to encourage disease. Soil sifted through a $\frac{1}{4}$ in. riddle may be placed in the pathways in readiness for covering the seed after sowing.

DATES OF SOWING. Successional sowings may be made from about October 12 to October 30 at intervals of approximately 5 days. The dates of the first and last sowing will depend upon the prevailing weather conditions. In mild autumns early sowings often produce "soft" and unsuitable plants. Sowings before or after October are not often advisable, but seed may be sown in cold frames early in January to produce a later crop. The seed is sown broadcast as thinly and as uniformly as possible, using about $\frac{1}{4}$ oz. per English light. The seed should be dropped at a distance of $\frac{1}{2}$ in. to $\frac{1}{4}$ in. apart. Afterwards, the sifted soil is carefully spread to a depth of about $\frac{1}{8}$ in. so as just to cover the seed. Black cotton is then stretched across the frames from nails driven into the woodwork at about 4 in. apart. This is necessary to deter birds, which may cause considerable damage to the seedlings later in the year when the lights are taken off or ventilated. The lights are placed in position and kept closed until germination begins. Thereafter air is given in gradually increasing amounts so that eventually the maximum possible ventilation is provided night and day, according to prevailing weather conditions. Constant care must be exercised, as previously indicated, against frosts, snow, rain and fog. It is particularly important that rain should be prevented from blowing into the frames when ventilation is provided. The steep slope at which the frames are built facilitates the entry of rain in this manner and it is often noticed that the first infections from Botrytis disease commence in areas made excessively wet from these causes, or from drips through leaking lights. Full provision must be made for securing the lights by means of ropes in rough weather. If the seedlings come up too thickly, they must be thinned as early as possible so that they stand at about 1 in. apart, and all weeds should be removed before they tend to smother the seedlings.

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Planting Out in Open Ground. Early preparation of the land is essential. Ploughing in autumn and the application of horse manure in heavy dressings up to 60 tons per acre is advisable. As soon as possible, the land is prepared for planting by harrowing, etc. A dressing of fertilizer should be applied at this time and may consist of the following mixture:—4 cwt. ground hoof and horn: 1 cwt. sulphate of ammonia: 2 cwt. sulphate of potash, per acre. If the previous crops were not limed, 2 tons per acre of hydrated lime may be applied.

In the south of England it is usually possible to transplant lettuce plants raised in this manner during February and March. Those raised under method (a) (i.e., pricked-out) are the first to be planted out. If the weather is open this may be carried out as early as the first or second week in February. Planting out of the seedlings raised under method (b) is often delayed until the first week in March. Cabbage lettuce plants are set out 10-12 in. apart in rows 12 in. apart; but cos lettuce are given wider spacing, e.g., 14 in. apart in rows 14 in. apart. The planting is carried out with a dibber, great care being taken not to plant too deeply or too shallowly (Fig. 4). If a "racer" or marker is used care must be taken not to make the drills too deep, or "peaked" lettuce may result from deep planting. A garden line is preferable. Great care must be exercised in lifting the seedlings from the frame and in conveying them to the field. The plants should be placed in trays and covered to prevent drying out by wind or sun.

After the young plants have recovered from planting, a light dusting of hydrated lime is beneficial. The lime helps to make available the manures, and discourages earthworms and slugs which may disturb or damage the plants. Hoeing should commence at an early date and be repeated frequently throughout the life of the crop. Irrigation, where available, may often make the difference between profit and loss, as a dry spell in spring may check the plants considerably and cause them to make poor growth or to bolt to seed.

An intercrop of cabbage, variety Primo, is sometimes grown with the lettuces. Cabbage plants are raised from seeds sown in January in heat, transplanted into frames and later planted at 16 in. apart in every other row of lettuce. This crop is perhaps only suitable for planting between the pricked-out lettuces.

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Cutting and Marketing. The crop should mature in May or June. Lettuces are cut early in the morning and the early crops are not usually packed on the field but are taken to the packing shed, where they are trimmed, graded, washed or dipped, and packed in crates holding 18, 24, 30, 36, 42, or 48 lettuces. Non-returnable crates, size $22\frac{1}{2}$ in. x $16\frac{1}{2}$ in. x 9 in., or $22\frac{3}{4}$ in. x $14\frac{1}{2}$ in. x 9 in., or $21\frac{1}{2}$ in. x 13 in. x 8 in., for cabbage lettuces are used, and returnable bushel boxes for cos lettuces. The lettuces are packed in two layers, with the hearts facing inwards to each other. If 70-75 percentage of the crop is marketed, this is generally considered satisfactory.

The following varieties have been found suitable for the purposes described :—

(a) **PRICKED-OUT SEEDLINGS**

Cabbage : May Queen, Milly, Watkins & Simpsons No. 2

Cos : Lobjoit's Green Cos.

(b) **SEEDLINGS THINNED BUT NOT PRICKED OUT**

Cabbage : Feltham King, Improved Trocadero, All the Year Round.

Cos : Lobjoit's Green Cos.

Diseases and Pests. The most common diseases while in the frames are Botrytis and Mildew.

Botrytis (*Botrytis cinerea*) is commonly called Red-leg, Collar rot or Canker. The disease is difficult to control and much depends upon seasons and upon the manner in which the plants have been grown. Some growers believe in sterilizing the soil with formalin before sowing or transplanting. Certain proprietary articles are available, but under certain circumstances seem to have a hardening effect on the growth of the plant. In the frames it is a wise practice to remove and burn diseased plants, including some of the surrounding soil, as soon as observed. No debris of any kind should remain on the surface of the soil in the frames. Careless handling of the seedlings when transplanted encourages infection.

Mildew (*Bremia lactucae*) appears on the seedlings as a whitish mildew on (chiefly) the under surface of the leaves. The leaves become yellowish in colour, later turning brownish and shrivelled. Any check to the growth of the seedlings, such as excessively dry or excessively wet soil conditions, appears to encourage the disease. Excessive humidity is also said to be conducive to the disease. While dusting preparations are available, on the whole it appears that the best means

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of control, apart from the good culture, is the removal of affected leaves as soon as the trouble is observed.

Out of doors, the chief troubles are Botrytis disease, aphid and wireworm, though occasionally Mildew is a factor. Really satisfactory control measures for wireworm have not yet been worked out. The pest is undoubtedly encouraged by dirty land and is often prevalent on land recently ploughed up from pasture. Care should therefore be taken not to plant lettuces on land likely to be infested with this pest. In some seasons lettuce aphid is a serious pest and may render the crop unsaleable. Infestation is often first noticed when severe and when the lettuces are more than half mature. Since the insects feed between the leaves and in the heart of the lettuce, they are extremely difficult to control. Growers are advised to keep close observation for the appearance of the first arrivals of the pest, when prompt application of insecticide sprays or dusts may achieve success.

Amongst other pests, the Turnip mud-beetle may be mentioned. This pest has been reported causing serious damage to lettuce crops occasionally in Middlesex, Buckinghamshire and Surrey. The grubs may be found boring into the stems of the young lettuce plants. Their presence is sometimes masked by Botrytis disease, which often follows the damage caused by the grubs. The chief control method recommended is attention to rotation of crops, particular care being taken not to follow lettuce after radishes or turnips.

HIGH GRADE MILK PRODUCTION AND MARKETING IN TYNEDALE

C. S. RICHARDSON,

Stocksfield, Northumberland

The writer became tenant of a 130 acre farm, 16 miles from Newcastle, in May, 1925. He had the expectation that the farm would ultimately be left to him and that an additional 100 acres could be taken in hand when required. The security thus offered encouraged reasonable expenditure of capital, when available, on necessary improvements.

The farm, with the exception of a six-acre field which had been ploughed during the War, was in 50-year-old grass. It had previously been let and worked as a family farm, selling milk wholesale from 16 cows, rearing the calves and grazing or feeding cattle in the summer on land not required for hay. About 30 ewes were also kept.

In 1924, certified milk was still rather a novelty. Inquiries showed that there was apparently a sufficient quantity of Ayrshire certified milk already trying to find a market, but that there was a small farm run only as a hobby which was supplying a Newcastle firm of retailers with about 15 gal. daily of certified Jersey milk, which was retailing at 8d. a pint, and that sometimes there was not sufficient of this milk available to satisfy would-be customers.

It had been intended to found an Ayrshire herd, but this unsatisfied market meant that Jerseys or Guernseys would have to be chosen. A visit to the Dairy Show in 1924 decided the matter easily in favour of the Jersey. An examination of the cards above each animal showed that the Jerseys on the average gave as much milk and more fat than the Guernseys. Jerseys could hardly be obtained locally and when the farm was entered foot-and-mouth restrictions prevented cattle from being brought into the county, so that very little milk was sold that summer. This appeared calamitous at the time, but actually it allowed the fields to be harrowed and cleaned up before tested cattle arrived in July. In the meantime an improved water supply was added, the byre renovated and made to hold 18 cows and the dairy fitted up, all as cheaply as possible.

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Mainly in-calf heifers were purchased from a herd in the South, and from Jersey. There was sufficient milk to apply for a licence for certified production in August and this was granted (it was about the 80th in England), and almost at once it was possible to sell about 12 gal. of certified milk at 4s. a gal. Other markets were diligently canvassed though without any spectacular success. It is, perhaps, interesting to note that a market was found in Scotland for this English milk and for many years small quantities up to 3 gal. have been going 130 miles daily to Edinburgh.

Milk surplus to certified requirements was sold as T.T. Jersey milk and went 100 miles to Leeds on a fixed quantity contract at about 6d. a gal. over the usual T.T. prices.

Zeal for Clean Milk. Before entering the farm, the writer spent a fortnight on a clean-milk course at the British Dairy Institute at Reading and became inspired with enthusiasm for the proper handling of milk; much of this enthusiasm persists 15 years later. The workers, too, became enthusiastic and, as a result, there were two surprise official counts of 0 bacteria per c.c. The milk has been used daily on the voyage to Bombay and been sweet on arrival, and a party of farmers visiting the dairy on a Wednesday have drunk milk saying that they never tasted better. It was produced on the previous Wednesday and was thus eight days old!

There have been two bad periods when the milk was not of sufficiently low count—once in summer due to a very small but undiscovered fault in the wire ring of the milk filter and another rather longer period in winter due apparently to a careless milker. Otherwise there has been little difficulty in maintaining the standard, that is to say, if the well-known rules are consistently followed by intelligent people for 365 days in the year.

Local opinion had suggested that Jerseys were not likely to thrive if brought from the south to this rather exposed farm, 400 ft. up and sloping slightly to the north. However, dry cows and heifers can lie out all winter without harm. The important thing is to keep the byre reasonably cool in the autumn and then they grow satisfactory coats for themselves. The milking cows go out in almost any weather for a short time in winter, and remain out day and night from mid-May to early October.

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There have been in 14 years about six reactors to the T.T. without any obvious explanation, but this was the first herd to become attested in Northumberland.

Contagious abortion appeared in 1929 and obtained a good hold, but was dealt with by live-germ inoculation of all breeding females for about three years, at the end of which time only about 20 per cent. reacted to the blood test. These were mostly sold to a farmer who had abortion in his herd and wanted to buy positive testing cows. Since then the blood testing has been continued with apparently satisfactory results. Additional accommodation was provided as the herd grew (it is now about 70 head), calving boxes, a new byre and a covered yard being put up. The dairyman's young family was growing up at the same time, so it was found possible to increase the herd, the staff and the milk sales simultaneously.

The bull calves, except from the best cows, are slaughtered at a few days old, and all heifer calves are kept. If the sexes have run about evenly two years previously there have been a number of useful heifers to sell as they calve at prices from £30 to £45, as well as replacing older cows in the herd. It is desired to keep the herd as self-contained as possible. Daily milk recording and individual butterfat testing are practised and the full time cows usually average between 8,000 and 9,000 pounds.

Ups and Downs. In 1929, the small farm which had provided the idea was broken up on the death of the owner, and an additional demand for milk resulted with considerable expansion of business and profits.

The business is, however, partly of a luxury nature, as the retail price is higher than that of ordinary certified milk; little attempt has been made to cut costs in the usually accepted sense, or the price of the product. The emphasis has always been laid on maintaining and improving the quality of the product. There was no option but to cut the price, however, when England went off the gold standard, for sales were cut by one-third within three months. Accordingly, the wholesale price was reduced to 3s. 4d. per gal., which slowed up the fall in sales; a year or so later it was further reduced to 3s. per gal. Sales then began to increase and gradually reached about 40 gal. daily in 1938. The last few months have shown some reduction from this peak, and the daily sale of T.T. Certified

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milk is now about 33 gal. The writer fears that guns and butter may prove as incompatible in England as elsewhere.

There have been throughout the period several modest advertising campaigns, never with any results sufficiently striking to make it clear that the advertising had achieved its object. The writer still believes that the maintenance of consistently high quality of the product is the best advertising medium for a small business which cannot stand the cost of extensive advertising.

Social Occasions. On two or three occasions we have had an "at home" day, choosing a Saturday afternoon in the summer, when all regular customers have been asked to bring their friends to tea, and to inspect the cows and dairy. On each occasion about fifty people came, many of them with rather little knowledge of the country. There is no question that these outings have been thoroughly enjoyed, by host and hostess as well as visitors, and they are likely to make a much more lasting impression than any other form of advertising.

The land is not naturally fertile (70 years ago it was described as "one continuous bed of whins, broom, wild roses and heather"), but it responds very well to basic slag. There are six or seven inches of soil which varies from a sandy loam to clay. In 1929, an additional 100 acres of poorish grass, one quarter of it cleared woodland, was added. The fields grazed by the Jerseys are reserved for them and sometimes sheep, and the remainder of the grass is grazed by a herd of 25 Angus cross or Blue-grey cows, which run with an Angus bull and suckle their own calves, which are born in March. This is a reversal of the usual local procedure which seeks to obtain its grazing cattle and its milking cows from the same dual purpose Shorthorn. The plan appears to work satisfactorily. The Jerseys demand the best of everything, the suckling cows are ready to be thankful for the hay which "just got a bit of a shower," and are themselves wonderful land improvers, grazing rough grass to the bone in winter and trampling all into mud; later basic slag has been sown and what was ten years ago a full-grown larch wood, with undergrowth of brambles and Yorkshire fog, is now full of wild white clover and provides excellent grazing. The calves are sold off their mothers in October, and even through the worst times have never averaged less than £10 each, and in a very good year £14 to £15.

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It has not proved difficult to have an "attested" and an untested herd on the same farm. The fields are double fenced around the Jersey herd, partly with electric fencing, and the suckling cows or grazing cattle never come to the steading at all. If it is necessary to have an odd cow inside at calving time, a small building with two boxes and a few stalls in their own fields has been sufficient.

A wagon of Irish cattle in summer and a flock of about 10 Suffolk and 60 half-bred ewes crossed with Suffolk tups completes the stock. The lambs are sold fat as soon as possible and are all away before Christmas. A few pure-bred Suffolk tup lambs for sale provide additional interest and hope of profit.

Land Improvement. A timorous start was made with breaking-up the old grass land the first year, when three acres were ploughed and sown with oats. Later, as experience and labour increased, about six acres were ploughed each year, taking oats twice, then roots and oats again undersown with seeds. In this gradual fashion, most of the fields where ploughing is practicable have been very much improved, the new grass providing several weeks more grazing than the old grass, better grazing and more hay. It now becomes apparent that this process might go on a little quicker as the earliest fields so treated are now going back. (Yorkshire fog is troublesome and encouraged by the fact that a considerable area of these young grasses must be mown for hay.) One field has been ploughed out and sown with wheat and grass seeds and another, far from the steading, ploughed and sown with grass seeds without a cover crop. Some hundreds of cartloads of stones have been gathered from these fields and the farm roads improved. Since finding the most suitable variety of oats, which appeared to be Eagle, they have stood and cropped well, averaging 29-30 cwt. per acre, and 20-25 acres of oats or wheat are usually grown. They are mostly sold, and a balanced dairy cake bought back, and in this way in recent years about one-third of the cake bills have been paid by the sale of home-grown corn. The 6-acre root break has to provide succulent food for as many cattle as possible; mangolds, kale and swedes are grown, and as much farmyard manure as possible is ploughed in, in the autumn. In 1938, this was supplemented by three acres of oats, beans, peas and tares, which were ensiled in a

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pit silo built 50 years ago, but unused for many years. The crop was cut too early and the fermentation largely butyric, although molasses were added, but it is hoped to remedy this with the present crop.

The staff consists of three men, one lad and two women, in two families which have worked here now for ten years or more. Waste of material has been on the whole regarded as even more serious than waste of time, and it has been felt that a strong permanent staff is more likely to prevent such waste of material because it has the strength to cope properly with emergencies; at the same time, since it is a permanent staff, the incentive to idle in order to prolong the period of employment should be absent. In this connexion forestry combines well with farming, the estate has about 100 acres of woodland, now mostly young, with thinning commencing. In farming, a great many operations must be done to-day, or at latest this week; forestry is different and many operations may be done almost equally well next month or next year. If the thinning is done by a competent forester, the handling of thinnings can be dealt with by the farm staff and horses in slacker times, and unsaleable timber converted on a small saw bench into firewood, rough boards, posts, etc., when the weather is wet. Additional labour is hired in haytime, to assist in the making of about 60 acres of hay. Almost all the grass fields have the grass cutter over them at least once a year.

Three horses are in regular employment, and an old hunter is kept at grass all the year and assists at hay time.

The writer has not felt cramped for lack of capital, though there have never been more than modest quantities available, and he has tried to effect some real improvement each year if possible. In this way, a new byre, an improved water supply, some field drainage, a covered yard, manure carrier, electric light, improved roads, milking machine, baths and water closets in workers' cottages, brine refrigeration and cold room, and a good selection of implements have been added.

These have contributed much to the efficiency of the farm and have enabled the staff to produce more with less effort. Where labour-saving apparatus has been introduced, a way has so far been found to allow for increased production or more leisure, rather than decrease of staff.

PLOUGHING AND SEEDING GRASS LAND : SOME PRACTICAL CONSIDERATIONS

W. A. C. CARR,

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A host of questions crop up the moment one contemplates ploughing out old turf, and it is essential to settle at any rate some of them before a start is made. It is never worth ploughing turf unless the farmer is prepared to put on enough lime to neutralize acidity and enough manure to ensure good crops afterwards. Some turf is too acid to be worth ploughing at all.

Plan of Campaign. Assuming, however, that the farmer is prepared to follow up the plough with appropriate lime, manure and seeds, the first question is the general plan of campaign. There are three possibilities :

1. On farms in good arable areas the plan may be to bring the turf into ordinary arable rotation at once.
2. On small farms throughout the west the aim is generally to get the land back into grass as soon as possible. The quickest return to grass is obviously got when the seeds are sown on the back of the furrow. It is, however, rare to get a really satisfactory take on land ploughed out of turf a few weeks previously. Moreover, the aggregate cost of ploughing, liming, manuring and seeding with a good mixture is high.
3. An intermediate plan may be followed, that is to say, the land may be ploughed, limed, manured and seeded down with commercial strains of grasses for a 2-3 years' ley, after which it is reploughed and seeded down with a special mixture, or it may undergo a course of cropping before re-seeding. This method I have used frequently in years gone by. More recently it was developed by the late Mr. Munhead of Borsdane, Westhoughton, near Bolton, Lancs, who demonstrated the possibilities of Italian rye-grass.

Ploughing. Turf can be ploughed out in two distinct ways :

- (a) It may be ploughed very shallow, i.e., " skimmed " fallowed or allowed to lie sometime before being cut up with a disc harrow and subsequently buried by a deep furrow. This method is successful with thin clean turf, but I found it unsatisfactory with matted turf.
- (b) It may be ploughed without previous disintegration of the surface. This is much the commoner procedure and is preferable if the land is to be directly re-seeded. Old turf is a test of both plough and ploughman. If a novice is to do the work, it is advisable to give him a new plough of a standard type which will be easy to adjust. Ploughs are made for various purposes and to suit particular soils, so care is necessary in selecting one. A good plan is to see the plough at work and handle it if possible.

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It is difficult to define good work, as types of ploughing vary and what may be considered good work in one district may be considered bad work in another, but certainly all grass and surface weeds should be buried. A disc coulter is essential for matted turf and a skim should be used when possible.

The ploughed land should be firm under foot. Loose work may be caused by cutting too deeply with the skim or by using a plough which fails to pack the space under the furrow. Admittedly this space is not easy to fill on heavy land but a good plough should twist the furrow and reduce the space to a minimum. The furrows should be made so that they can be harrowed or worked down to form a deep tilth. Many advise a flat furrow which makes ready contact with the unmoved soil but the furrow should not be too shallow, especially with matted turf. Personally, I prefer a well set up furrow, at any rate in areas of moderate or heavy rainfall and when it is likely to remain unbroken for some time. The worst type of ploughing is that which stands on its end, with furrows unclosed, as weeds and unwanted grasses then come through easily; moreover the furrows rock under the harrows and it becomes extremely difficult to force a tilth. It is not easy to avoid open work here and there when multiple ploughs are used on an uneven surface of matted grass, and time should be allowed for plough adjustments.

The depth of furrow depends on the nature of the soil and the capacity of the plough to turn a sufficiently wide slice. Raw subsoil should not be brought to the surface unless the mat is very thick and the soil thin. In general a furrow 6-8 in. deep and 10-12 in. wide can be recommended.

Harrowing. A deep tilth is desirable for all crops; even grass and clover seeds do better when the furrow slice is broken to a good depth before it is rolled or worked into a firm seed-bed. Somehow an idea has grown up that grass seeds need only a scratch with a light harrow. There is no greater fallacy. Poor tilth is one of the commonest causes of failure when re-seeding ploughed up turf or in sowing down in winter corn. Admittedly seeds take well on headlands where the soil is hard, but headlands tend to be double sown with both seeds and manure; they are repeatedly harrowed and trampled by horses and implements and the nurse crop is often thin. A light harrow is ideal for seeds once a fine tilth has been procured but a light harrow is out of place on a hard surface.

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The disc harrow is an excellent tool for working the back of a matted furrow. Unfortunately, discs are expensive and are not common on small farms where there is little tillage. Given patience, ordinary harrows will do the work, provided the tines are kept sharp and the ploughing has been reasonably well done. They should be drawn a number of times in the direction of the furrows and if necessary weighted—it is a good plan to place one harrow on top of another, or to put a box on top and let the driver sit on it. Later, “strokes” should be done at an angle or across the furrows. Drastic methods which result in bringing turf to the surface should not be employed.

Fertility. Matted turf is invariably acid and may require anything from 1 to 4 tons of lime per acre. The approximate lime dressing can, of course, be determined by laboratory test. If a heavy dressing of lime is necessary, lump or small lime can be slaked by adding water to the heap and then spread with a shovel from a cart or lorry. Low-priced ground limestone can also be spread from a cart. When the lime requirement is small, it is preferable to apply bagged lime with a manure distributor. After application, lime should be harrowed into the soil; burnt lime cakes on the surface if exposed to rain.

Old grass land usually contains much plant food, but this is not immediately available after ploughing. This is particularly true of phosphate, which should therefore always be supplied before re-seeding or sowing another crop. Soluble nitrogen and potash are also necessary if a new crop is to be quickly established. Farmyard manure can be applied on the old turf before ploughing or reserved to top dress seeds the following autumn. Earthworms seem to be absent on poor acid grassland, but they return after application of lime and farmyard manure. These fertilizers also help to provide suitable conditions for useful soil bacteria which seem to be more or less absent in matted turf.

Cropping. The possibilities of cropping ploughed-up turf are almost endless. Where it is not desired to alter the total area of plough land, the old turf can be brought into rotation and a similar area of old tillage can often be laid away to grass. A possibility which ought always to be considered is that of lengthening the rotation so as to allow of three- or four-year leys. There can be no doubt about the potential productivity of short leys under good management; and a hundred acres

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under a six-course shift which includes three-year leys involves no more arable work than 70 acres under a rotation of the " Norfolk " type.

The immediate concern after ploughing is, of course, the first crop. Winter corn usually does well on ploughed-up turf, provided the ploughing has been done early enough and the cultivation has been thorough. Late ploughed land is liable to be open and needs much consolidation. In the north, wheat should be sown early—the end of September or early in October—so that the plant is well established before winter.

In areas of moderate rainfall, autumn seedings of grass and clover are worth consideration. There is, of course, an element of risk in this procedure and success depends in great measure on the weather. Clover is liable to fail in wet winters unless it is well established by the beginning of December. Seeding in any event should not be deferred beyond the end of September.

When old grass is ploughed in October, the land should, as a rule, be allowed to lie in the furrow, uncropped, over the winter; it should not be harrowed. Frost and spring harrowing should be relied on to secure a tilth. Suitable spring crops in the North include oats and grass. Spring oats should be sown not later, if possible, than the end of March, as frit fly is particularly liable to cause trouble on newly-ploughed turf. Grass seeds also should be sown in March, or at latest, early in April. Late seeding has in my experience, been the commonest cause of failure or partial failure in re-seeding trials.

Re-establishment of Grass. The method to be pursued in re-establishing grass depends in great measure on the need for grazing and winter fodder respectively.

If the ploughing has reduced the *hay area* of the farm it may be desirable to produce in the first year a crop which will yield winter fodder. In these circumstances, I have on many occasions in recent years, seeded down with a grass mixture in oats or oats and peas, cut the cover crop in June for silage or hay, and then turned on cattle or sheep. It seems desirable to use a rather thin seeding of oats—about 3 bushels per acre in Cheshire—and it is certainly sound practice to cut the cover crop before it shoots. The earlier the cover crop is removed, the more rapidly do the grass and clover develop; on land in good heart an astonishingly close sole can be obtained by this method in the first year.



FIG. 2 - The field early in June

To face p. 55b.

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If the ploughing has resulted in a restricted *grazing area*, the prime object in management becomes that of providing pasture quickly. For this a grazing mixture, plus 15-20 lb. Italian rye-grass should be used, and stock can be turned on as soon as there is anything appreciable to graze. I have employed this method on many farms this year, and in every instance where the seeds were sown before Easter, a good "take" has been obtained. With later seedings, results have been variable. Italian rye-grass seems rather fickle if drought supervenes.

Catch-Crop Grass. As stated earlier, however, ploughed-out, old matted turf does not as a rule make an ideal seedbed for a long term grass and clover mixture. It is difficult to make really "solid"; it is almost impossible to prevent some of the old grasses and weeds from coming through; and most of its stored up fertility is but slowly available. Moreover, the cost of ploughing, manuring and re-seeding with a good mixture can seldom be kept down below £6 per acre. Admittedly part of this is at present recoverable, but even so, ploughing out is emphatically a big undertaking, justifiable only if a really good turf is ultimately obtainable. For these reasons, the device of sowing down in the first place with a temporary mixture—a sort of grass catch crop—is in many ways attractive. By this device the old turf is allowed two years in which to decompose, and a much better seedbed is ultimately obtained. Muirhead had great success with a thick seeding of Italian rye-grass, which he termed arable grass. He claimed that good grazing could be obtained within two months of seeding and that an exceptionally early bite could be obtained before laying up for hay the following year. A trial of this kind at present in progress at Reaseheath throws some light on possibilities.

A 4-acre field of worn-out ley was mucked and ploughed up in March of the present year. The surface was worked into a deep tilth with the aid of a disc harrow and 12 cwt. of 9 per cent. slag and 2 cwt. of a complete fertilizer (per acre) were applied to give the crop a good start. The following mixture of seeds was sown on April 6:—

Italian rye-grass	35 lb. per acre.
Broad leaved red clover	5 " "
New Zealand wild white clover	1 " "

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The crop was ready for grazing by the middle of May. At this time the surface was so dry and soft that one scarcely dared turn on stock to graze. It was, however, decided to risk grazing part of the field and to allow the remaining part to grow for hay. On May 18, seven yearling heifers were turned on to the one part. The cattle were expected to top off the grass and in so doing make a mess of the field, after which they were to be taken away to give the seeds time to recover. Actually they did little or no damage and during the hot dry weather which tended to dry up established pastures, the herbage grew apace and the stock had to be increased. The ungrazed portion had also grown well. By the middle of June it showed signs of going down, so it was mown and carted off to augment failing pastures elsewhere. The dividing fence was removed on June 16, and since then the whole has been grazed for a short spell by a herd of cows, then for a period of three weeks down to the time of writing, by six heifers, four yearlings and a bull, the equivalent of $1\frac{1}{4}$ cows per acre. The surface is now firm and the earlier grazed portion shows a close bottom of leafy herbage. It is noteworthy that no scouring has occurred on this exceptionally young pasture.

Causes of Failures. Looking back over past experiences in dealing with ploughed out turf, the following stand out as the more important causes of failures and part successes:—

1. Late sowing. Spring oats suffer from frit fly and seeds fail owing to drought.
2. Poor tilth and seeds not buried. Caused by indifferent ploughing, inefficient harrowing and failure to make a firm seedbed.
3. Acidity and low fertility. Poor turf is usually acid and deficient in available plant food.
4. The smothering effect of the cover crop on seeds. Corn may be too thick or become laid. Italian rye-grass will suppress other grasses unless grazed.
5. Weeds and undesirable grasses. Old turf imperfectly buried or brought to the surface too soon after ploughing.

FEEDING STANDARDS FOR FARM ANIMALS: VI. THE VITAMIN REQUIREMENTS

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The Hannah Dairy Research Institute

The five previous articles of this series have dealt with the energy, protein and mineral constituents of the ration. The series would not, however, be complete without a brief discussion of the vitamin requirements of live stock.

It is now some 25 years since the first vitamin was discovered, and although the importance of these so-called " accessory food factors " has been amply demonstrated in the field of human nutrition, it is only during the past four or five years that reliable information has been obtained regarding their significance in animal feeding. Moreover, in assessing the value of existing information *from the point of view of practical rationing* it is still necessary to preserve a somewhat conservative attitude. There are three reasons for this. In the first place, the tendency in the past has been to assume that results obtained with small laboratory animals (e.g., rats, mice and guinea pigs) can be applied directly to the larger farm animals. As a result of recent work it has not only become evident that results on laboratory animals are frequently inapplicable to farm stock, but it has been found that the deficiency symptoms obtained with one species of domestic animal are not necessarily identical with those obtained with another species, nor are the vitamin requirements of the various species necessarily the same. In the second place, it frequently happens that, in order to determine the effect of a given vitamin deficiency on farm stock, the rations require artificial adjustment and do not therefore represent those used in typical feeding practice. Thus, for example, a ration composed of rice screenings, purified casein, minerals and cod-liver oil has been used to demonstrate the relation of the vitamin B complex to the growth and health of pigs, and typical deficiency symptoms have indeed been obtained. But clearly such a ration would never be used in normal feeding practice. In the third place, the number of experiments which have so far been carried out with the larger domestic animals is in any event still very limited, and available information regarding the requirements of such animals is, therefore, inevitably somewhat meagre.

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Vitamin A. With experimental laboratory animals a deficiency of vitamin A results in a decreased growth rate, a decreased resistance to disease generally, and an eye disease (xerophthalmia) which frequently leads to complete blindness. Recent work shows that a ration which is seriously lacking in this vitamin may also lead to certain deficiency symptoms in farm animals. Such symptoms vary according to the species. Experience in the United States shows that with cattle one of the earliest symptoms is "night blindness" (inability to see in dim light owing to degeneration of the retina), while reproductive troubles, somewhat akin to those which occur as a result of contagious bovine abortion, are also observed. Attention has also been directed to the possible relation between the occurrence of white scour in calves and the existence of a vitamin A deficiency in the dam. Jordan, in a survey of Ayrshire herds carried out in 1933, drew attention to the marked seasonal variation in the incidence of this condition, and suggested that it might be associated with a progressive vitamin A deficiency which would result from prolonged feeding on winter rations. In the same year, two Californian workers, Hart and Guilbert, observed symptoms resembling white scour in calves whose dams were receiving inadequate supplies of vitamin A. The validity of the conclusions drawn from these two sets of field observations has quite recently received support in work carried out at the Moredun Institute, in which the vitamin A potency of colostrum was related to the incidence of white scour. It was found that there was practically a three-fold increase in the number of cases among calves whose dams were giving colostrum of relatively low vitamin A potency.

The vitamin A deficiency symptoms shown by sheep (though of extremely rare occurrence in animals which are invariably reared on pastures) are in general similar to those shown by cattle. With pigs, however, nervous symptoms predominate. Thus in experiments carried out in Denmark with young pigs, although there was no decrease in growth rate in the early stages, the central nervous system soon became seriously affected and a form of swine paralysis developed. Such paralysis was sometimes distributed uniformly throughout the animal or was more severe in some parts of the body than in others, e.g., on one side of the face or in the hind legs. Experiments at the National Institute for Research in Dairying have given very similar results. The growth rate only decreased after the pigs had reached a weight of over 250 lb., i.e., above bacon

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weight. The same nervous symptoms were observed and could usually be cured by administration of a vitamin A concentrate. A striking fact in connexion with the Reading results, as well as with certain earlier experiments carried out by Dunlop at Cambridge, was that the rations fed (barley meal, weatings, soya-bean meal, meat meal and minerals) were typical of many ordinary pig mixtures—in fact the rations had been selected for this reason. The Reading workers suggest that the only reason why vitamin A deficiency symptoms are not more common is the widespread custom either of giving pigs access to pasture or of providing green food or a fish oil, such as cod-liver oil or halibut-liver oil.

These various additions to the diet provide rich sources of vitamin A or of its precursor carotene. Carotene occurs in green foods such as pasture grass, kale or other leafy material, and in artificially dried grass and well-made grass silage. Owing to the destructive action of light it is, however, only present in small quantities in hay, and particularly in low-grade products such as timothy hay. The Danish workers suggest that for pigs as little as 1 oz. of fresh grass per head per day will supply sufficient carotene to ensure satisfactory health and growth, though in this country at least double this quantity is recommended. For cows during gestation 2-3 lb. of fresh grass (or say $\frac{1}{2}$ lb. of good quality dried grass) should provide enough carotene to ensure normal reproduction and to minimize the risk of white scour in the calf. If green food is unobtainable, either cod-liver oil or halibut-liver oil can be used as a source of vitamin A. As regards calf rearing, it has been found that colostrum is many times richer in vitamin A than milk, and it is therefore essential that the calf should receive its dam's colostrum as soon as practicable after parturition.

It may be noted that animals are capable of building up reserves of carotene or vitamin A in the liver. This fact has led Dunlop of Cambridge to put forward the interesting suggestion that live stock having a limited life span might conveniently be provided with an adequate supply of this vitamin by the administration of a single massive dose of a suitable concentrate—say 300-400 times the normal daily allowance. Under such circumstances the breeder could probably rear his pigs in a healthy state up to, say, 200 lb. live weight without the necessity of considering the vitamin A requirements during the actual growth period. The practical

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utility of this procedure has recently been confirmed by the Reading workers.

Vitamin D. Vitamin D is essential for the growth of all species of farm animals, being concerned particularly with bone formation. The quantity of this vitamin which must be supplied in the ration varies, however, not only with the individual species, but also with the actual level of calcium and phosphorus in the diet. Moreover, any attempt to arrive at an exact figure is further complicated by the fact that exposure to sunlight enables the animal to synthesize its own supply of vitamin D. During the summer months cattle at pasture will not normally require any special source of vitamin D, and the same argument applies to pigs reared in the open. As regards winter or indoor feeding, few foods supply vitamin D in any considerable quantity. Hay which has been exposed to sunlight during curing is an exception, and the inclusion of, say, 5 per cent. of such hay in the ration should provide an adequate protective dose against any risk of vitamin D deficiency. Where this is impracticable, the deficiency may readily be made good by judicious dosage with cod- or halibut-liver oil. The addition of excessive quantities of cod-liver oil has, however, been shown in experiments carried out at Harper Adams College to have a deleterious influence on the quality of the bacon fat, while the effect on milk production is also liable to be harmful, experiments at Reading and elsewhere having shown that amounts in excess of 2-4 oz. per cow per day tend to cause a marked reduction in the butter-fat content. The unique value of this form of fish-liver oil is, however, unquestionable, and in the latest edition of *Rations for Live Stock* a special section has been devoted to practical recommendations regarding the quantities which can be safely fed to stock. These recommendations provide adequate guidance for practical breeders. It may perhaps be noted that the somewhat widespread impression that grass (whether fresh or artificially dried) forms an exceptionally rich source of vitamin D is erroneous. Both fresh and dried grass are excellent sources of vitamin A (as carotene) and also supply valuable quantities of calcium. The apparent beneficial effect of grazing in preventing the symptoms of vitamin D deficiency is, however, chiefly due to the direct effect of the sunlight to which the animal is necessarily exposed, and not to any specific value of the herbage.

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Vitamin B Complex. It has already been noted that the feeding of rations specially adjusted to contain inadequate amounts of the vitamin B complex will result in typical deficiency symptoms in pigs. Such deficiency symptoms (which have been observed in independent experiments carried out at Cambridge and Reading and in California) include loss of appetite, poor growth, emaciation, nervous symptoms (paralysis) and symptoms similar to those of human pellagra. In practice, however, these symptoms are never found in pigs fed on normal rations. This is due to the fact that the vitamin B complex is widely distributed in the common feeding stuffs, cereals, weatings, green foods and skim milk being particularly rich sources. Indeed, even wheat straw, when used as bedding for pigs, has been found to supply sufficient of the complex to prevent deficiency symptoms.

As regards cattle the same argument holds, i.e., that practically all normal rations will contain adequate quantities of the vitamin B complex. Moreover, even in the absence of a suitable vitamin B-rich food in the diet, it appears that the rumen bacteria are capable of synthesizing at least part of the complex. This was shown in ingenious experiments carried out by Bechdel and his associates at Pennsylvania, where samples of rumen contents were periodically removed from the paunch through a permanent fistula and were tested for their vitamin B content by rat-feeding experiments. Thus ruminants are provided with a double safeguard against any possibility of vitamin B deficiency.

Vitamin C. Vitamin C is an essential constituent of the human diet: in its absence scurvy rapidly supervenes. Similar symptoms are found with certain species of animals, e.g., guinea-pigs and monkeys. Experiments with farm animals have, however, so far failed to indicate the need for this vitamin in the rations of farm stock. Workers at the Rowett Institute showed as early as 1924 that it was not essential for pigs, and this finding has recently been confirmed in experiments at Reading, where growing pigs were able to thrive on a ration capable of causing severe scurvy in guinea-pigs. It has similarly been found that neither calves nor sheep require vitamin C, at any rate not in quantities greater than are present in any normal ration.

Vitamin E. It was shown by Evans and his co-workers in California some fifteen years ago that vitamin E was essential

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for normal reproduction in experimental rats. In its absence the males tended to become permanently sterile, while with the females pregnancy was liable to be prematurely terminated by the death and resorption of the foetus. It was natural that this discovery should raise the question as to whether sterility in farm live stock might be partly attributable to a vitamin E deficiency. The balance of evidence appears to be against this view. Earlier experiments in Denmark indicated that vitamin E administration was effective in curing sterility in dairy cattle, but these findings have not so far been confirmed. Workers in the United States have failed to obtain any beneficial effect on reproduction in either pigs, goats or sheep. The subject is a difficult one to study, partly because of the ability of the body to store vitamin E, and partly because the vitamin is very widely distributed in the more commonly used feeding stuffs (particularly in green foods and cereals) and is therefore seldom lacking from the normal rations of stock. This latter fact indicates that, even if symptoms of vitamin E deficiency could be produced by artificial alterations to the diet, such an experiment would be of academic rather than of practical interest in so far as the feeding of farm animals is concerned. It has, however, recently been pointed out that since the richness of cereals in vitamin E is associated with the presence of the germ layer, any substantial increase in the use of degerminated meals might necessitate a re-consideration of the whole subject.

Vitamin Content of Milk. In conclusion, some reference should be made to the effect of nutrition on the vitamin content of milk. In brief, it may be stated that, apart from vitamin A, the vitamin content of the ration has little effect on that of the milk. It has already been stated that vitamin D is chiefly supplied by the direct action of sunlight on the animal, and the Reading workers have shown that this is the dominant factor affecting the vitamin D content of the milk. The same workers have shown that the level of vitamin C in mixed milk is remarkably constant, being relatively independent of the type of the ration fed. Moreover, so far as human requirements are concerned, the vitamin C potency of milk is now known to be markedly reduced by exposure either to light or to heat, so that infants on a milk diet invariably need some supplementary source of this vitamin. As regards the vitamin B complex, attempts to increase the potency of milk by special feeding have not on the whole been successful though, on

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account of the high vitamin B content of most feeding stuffs, the potency is never likely to fall to an abnormally low level. It may be noted that milk is at all times relatively poor in vitamin E.

As regards vitamin A, there is no doubt that the milk potency can be markedly increased by the inclusion of rich sources of this vitamin in the food, e.g., by feeding green foods of high carotene content or by administration of cod-liver oil. The inclusion of the latter will also to some extent raise the vitamin D content of the milk, particularly with animals housed indoors. There is, however, an upper limit of vitamin A potency beyond which the feeding of an additional concentrate will have no effect, and in any event the efficiency of utilization of such a concentrate is low. It is, therefore, very questionable whether (apart from including a sufficient quantity to safeguard the animal's own health) the feeding of vitamin-rich concentrates in an attempt to raise the vitamin potency of the milk could be economically justified.

BRINGING THE TRADESMAN UP TO DATE

How the Rural Industries Bureau Helps Farmers

J. A. B. HAMILTON

From earliest times the cultivator has possessed his attendant retinue of skilled tradesmen. It is true that a recent authority dates the invention of the horseshoe not before the ninth century, and of the horse collar as late as the eleventh, but Tubal Cain is an ancient legend, and the woodworker's craft goes back to immemorial antiquity. To-day the farmer neither shoes his own horses nor makes his harness or carts, nor as a rule repairs his own buildings. When implements wear and break, he cannot forge or fashion new parts, nor if he is wise will he attempt serious repairs to tractors or machinery. This is as it should be, for division of labour spells efficiency, from which the farmer has the most to gain.

For centuries the services of the tradesman to the farmer remained unchanged, but the advent of the industrial era began to undermine the tradesman's position. Farm gear, previously village-made of necessity, could be produced more cheaply in towns; new mechanical devices appeared outside the tradesman's range of experience. Horseshoes, carts and harness there were still in plenty to make and repair, but these began slowly to diminish when the agricultural slide set in after 1880. Now the motor has appeared to turn village life inside out and rob the tradesman of most of what work was left to him. He has been thrice smitten. Remember *that*, farmers, next time you feel tempted to quarrel with a disgruntled smith!

It was at this point that the Bureau was called into being to counteract the decline. It was realized that the tradesman was in serious danger of vanishing altogether, to the detriment of agriculture and the whole of village life. But his skill was still needed by farmers, if only he could adapt it to present-day needs.

It is the Bureau's purpose to adapt that skill, and its method may be summed up in a word—education. No subsidies have

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fallen to the lot of the tradesman; he must be efficient or perish. Thanks to the Bureau, an increasing number of men are becoming efficient and have abandoned their old-fashioned ways. These are the men who can offer the farmer the service he requires.

To take a few instances in point. The blacksmith's traditional work is at the forge. That experience has given him a knowledge of the behaviour of metals under heat, which is invaluable in the new process of oxy-acetylene welding. Now oxy-acetylene welding, as all progressive farmers know, is a money-saver of the first order. Almost any part of modern agricultural machinery or implements can be built up or mended by its help, and the finished job is as strong as a replacement part, and far cheaper. Few blacksmiths, unfortunately, have been far-sighted enough to realize this, and oxy-acetylene welding has got into the hands of garages, where often half-skilled mechanics botch the work and throw the whole process into disrepute.

The Bureau has made it one of its principal tasks to interest smiths in oxy-acetylene welding, and to educate those who have taken up the process to become thoroughly efficient. As a result, there are now a number of smiths who can offer farmers a first-class service and save them pounds in old parts renewed and time waiting for spares to arrive. This year the Bureau found a smith in Wiltshire who had been asked to repair a combine cylinder-head, cracked through exposure to the December frost. This smith possessed a welding outfit, but lacked the knowledge necessary to handle such a large casting. Under instruction from the Bureau he carried out the job with complete success. His charge to the farmer was £6; a new cylinder-head would have cost £25. Result: £19 saved to the farmer and a smith able to tackle any job of the same kind in future.

The day of the machine has arrived, and every year 5,000 new tractors take their place on the land. The farmer who uses tractors has been compelled to face a new set of conditions. To shoe his horses and repair his carts, he has always had a tradesman within call, but tractor agents by comparison are few and far between, and he is often thrown on his own resources. Agents do their best to give a service, and it is on record that one sent his man 20 miles to turn on a petrol tap, but not all agents are so accommodating, nor is every farmer anxious to trust the care of his tractors to one of his own hands.

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Few farm workers are sufficiently knowledgeable to adjust carburetors or clutches, and it is false economy to entrust this work to a man of doubtful skill. A skilled service man ready at hand is an asset of great value to farmers, and the Bureau is training smiths to become efficient mechanics, able to handle as may be required tractors, binders, combines or any other kind of farm machinery. This particular effort is yet in its early stages, but in course of time the Bureau hopes to train a body of expert smiths, co-operating with agents, who can diagnose any trouble in the field and execute running repairs.

So also with woodwork. The pitsaw is now a relic of the past, but the well-equipped and up-to-date woodworker, able to do any job from building a cart to repairing a cottage, and do it well, is a man worth keeping in the village. Craftsmanship is always of value, and the lack of it a source of loss, as may often be seen as regards the recent innovation of mounting carts on pneumatic wheels. Here the wheelwright has no traditional knowledge to guide him, and too often he falls down badly. Most carts on pneumatics are a painful sight, with weak or clumsy mountings, too heavy or else ill-adapted to withstand the racking stresses inevitable in field haulage. The Bureau is teaching wheelwrights to mount carts on pneumatics scientifically, and at the same time to produce a cart that will tip its heavier load without main force or the risk of fracturing shafts, a common evil with the badly-constructed pneumatic cart.

These are a few examples of how the Bureau helps the tradesman to serve farmers. Even more valuable perhaps in the long run is the general education in technical and business efficiency, which converts him from an out-of-date survival into a progressive and enlightened craftsman. It may seem a small matter that the wheelwright has obtained an efficient circular saw, but if that better saw, and similar improvements, help to keep him alive in the village the farmer will have a man at hand to do his work instead of having to go many miles to find a woodworker, as has happened in parts of the country where tradesmen have been allowed to drop out. An efficient tradesman means better service and a cash gain to farmers. And it means something more. It means that a business has been created worth a young man's while to take up. It is natural for boys to seek to enter go-ahead trades, and by giving these trades the prospect of a future the Bureau is beginning to revive the nearly extinct institution of apprenticeship. Several



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County Councils are giving financial help to newly-started apprentices, and in this way the principal trades should be assured of survival.

There is yet another way in which the Bureau's services help the agricultural community. The tradesman is prone to a certain bitterness born of his disasters, for which he is perhaps over-apt to blame the farmer. The Bureau trains him to forget his grievances, and to abate a hostility to his customers which is unfortunate however understandable. Prompt and willing service is an essential of modern business, and the Bureau's constant effort is to produce tradesmen who can deliver the goods efficiently and with a good heart.

But to do this needs mutual goodwill, and may I in conclusion address a plea to farmers? Not all of you have good tradesmen at your call, but if there is the right type of man anywhere within reach the Bureau, through its local agents the Community Councils, will put you into touch with him. But if you have a good man, do please use him. I was talking to a farmer the other day about his portable iron hurdles, which had reached a shocking state of disrepair. "Why don't you go to R——?" I said (mentioning a nearby smith); "he has got an oxy-acetylene welding plant, and he could make a good job of them for you quite cheaply." The farmer pricked up his ears. "A welding plant?" he asked, "how much does that cost?" Useless for me to try to tell him that to purchase a plant for himself would be sheer waste. He had got into the habit of dispensing with his tradesmen, and he would rather go on tinkering with his hurdles than use a service at his doorstep. Surely that is just as short-sighted as some tradesmen's antipathy to their customers. Let us have understanding all round, and the Bureau will continue to do its utmost to produce tradesmen worthy of the farmer's confidence.

The address of the Bureau, which will be glad to advise farmers and others on matters coming within the scope of this paper, is 14 Manchester Sq., London, W.1.

SCIENCE AND THE FARMER—III: NITROGEN AND ORGANIC MATTER

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The chemistry of nitrogen is a very difficult and involved subject that is, as yet, far from being fully understood. The nitrogen supply of the plant is, however, a matter of prime importance in crop production, and, as is well known, the amount and the nature of the soil organic matter (humus) is important from other points of view apart from its value as a source of nitrogen.

The forms in which nitrogen occurs in nature are almost numberless, but, from the farmer's point of view, they may be roughly placed in five groups.

First is the element itself, which is a gas and constitutes nearly four-fifths, by volume, of the air. The total amount of nitrogen in the air runs to many thousands of tons per acre of land surface, so that there is an inexhaustible supply of the raw material out of which nitrogen compounds can be made. Nitrogen is, however, a very inert gas, i.e., it can be made into compounds with other elements only with great difficulty and with the expenditure of a great deal of energy.

Secondly we have simple and so-called "inorganic" compounds, of which the most important are nitric acid (HNO_3) with its salts (nitrates), and ammonia (NH_3) with its salts, such as sulphate of ammonia. It is a peculiar fact that the one compound is a strong acid and the other a strong base, so that if ammonia gas is bubbled through nitric acid the two unite to form ammonium nitrate (NH_4NO_3).

Thirdly we get the group of organic compounds which are built up by the plant, and which provide the nitrogenous food of animals. The simpler of these are called amino acids, and the more complex, built up of a number of amino acids, are known as proteins. Intermediate between these substances and the inorganic group is urea, which is the commonest form in which waste nitrogen is passed out of the animal through the kidneys. Urea is a compound of carbon, oxygen, hydrogen and nitrogen $\text{CO}(\text{NH}_2)_2$ and readily combines with water to

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form ammonium carbonate (smelling salts) $(\text{NH}_4)_2\text{CO}_3$. This is an unstable substance which readily gives off ammonia into the air, and its breakdown explains the smell of ammonia that is given off by stale urine.

Fourthly is the actual living substance of plants and animals (protoplasm), which is a watery jelly of immensely complex composition. The dead, dry matter of protoplasm contains about a sixth part of nitrogen.

Lastly are the remains of plant and animal substances which have been subjected to putrefaction and decay—the soil humus, peat and coal. The common feature of these substances is that they contain much less nitrogen than proteins, and give up what they have very much less easily.

Only a few plants can make use of the free nitrogen of the air or, on the other hand, feed directly upon the organic compounds. The majority must take up nitrogen compounds from the soil, and the only forms that can pass through the membrane of the root hair are the simple inorganic substances—nitrates and ammonia.

A certain amount of the nitrogen of the air is brought into combination by natural processes unconnected with life. At the high temperature of a flash of lightning nitrogen combines with oxygen to give an oxide, and this, dissolved in rain, makes nitric acid. The farmer thus gets a free annual top dressing of nitrogen and it is this that partly accounts for the fact that a piece of unmanured land, like the plot on Broadbalk field at Rothamsted, will continue to produce a wheat crop of sorts for an indefinite period of years. But the amount of nitrogen so obtained is far short of the farmer's requirements.

Fifty years ago the supply of nitrates and ammonia for purposes of soil fertilization was becoming a matter for anxiety: the Chilean nitrate beds were obviously not inexhaustible, and the output of sulphate of ammonia from gas-works etc. could not be materially increased. The situation has, of course, been met by the invention of chemical processes for "fixing" the nitrogen of the air. Nitrate of lime is produced by a process that imitates the action of lightning; ammonia is made by mixing nitrogen and hydrogen and passing the mixture over what is called a catalyst at a high temperature and under enormous pressure. Both these processes involve a great input of energy, which is obtained either from water power or from coal. Nevertheless, they have provided the farmer with unlimited supplies of nitrogen fertilizers at comparatively low

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prices. It may be recalled that, in 1913, the price of sulphate of ammonia was about £14 per ton, or nearly twice the present figure.

The behaviour of nitrates and ammonium salts, when these are applied to the soil, is not hard to understand. Nitrate, like any other soluble acid radicle, remains in the soil solution and forms no compound with the clay fraction. If water is percolating down to the drains it carries the nitrate with it. Losses are therefore inevitable whenever drainage water escapes. Moreover, the loss is not avoided if drainage is prevented, for under water-logged conditions certain soil bacteria destroy the nitrate in order to get the oxygen which it contains, and free nitrogen goes back to the air. Hence, as is well known to farmers, nitrates are best applied as top dressings after the crop has been established, and when there is a network of roots waiting to absorb it. Only in the drier districts, and at the drier seasons of the year, is it safe to apply nitrate at seed time.

Ammonia, as such, is very firmly held by the soil; it behaves in the same way as potash, uniting with the clay radicle. Unfortunately, if the soil is warm and well aerated, ammonia does not persist, but is oxidized by the nitrifying bacteria, giving nitric acid and water:— $\text{NH}_3 + 2\text{O}_2 = \text{HNO}_3 + \text{H}_2\text{O}$. Under ordinary summer warmth, and with a moist soil, this change is carried through in a matter of days; on the other hand sulphate of ammonia will remain for a long time in the top layer of a dry soil, and no effect will be seen until there is a shower. Nitrate, on the other hand, absorbs moisture readily from the air, and often penetrates the soil without the help of rain. In nitro-chalk, the nitrogen is combined as ammonium nitrate and therefore this fertilizer is intermediate, in its rate of action, between sulphate of ammonia and nitrate of soda or nitrate of lime.

A secondary effect of sulphate of ammonia upon the soil, and one that is important in certain circumstances, is that its use increases the loss from the soil of lime and other bases. In itself it is a neutral substance (neither acid nor basic) but the change which the ammonia undergoes converts it, in effect, into a mixture of nitric and sulphuric acid, both of which combine with, and use up, the bases of the soil. The Aberdeen drainage investigations show this clearly. One drain gauge, of uncropped soil, was left unmanured, while another, over a period of years, had sulphate of ammonia to the amount of nearly six cwt. per acre.

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The figures (in lb. per acre) were :—

	No Manure	Sulphate of Ammonia	Difference
Nitrogen applied as sulphate of ammonia	0	119	119
Nitrogen in Drainage Water as ammonia	1	1	—
as nitrate	122	245	123
Bases in Drainage Water			
Lime	167	415	—
Magnesia	41	200	—
Soda	102	136	—
Total Bases	310	751	441

Thus the whole of the nitrogen applied as ammonia appeared in the drainage water as nitrate, and the six cwt. of sulphate of ammonia applied led to a loss of nearly four cwt. of bases.

Despite this disadvantage, it may easily happen that, all things considered, sulphate of ammonia is the best nitrogen fertilizer for the particular purpose that we have in mind. Its effect upon the lime status of the soil must not, however, be forgotten. In some of the Woburn experiments, for instance, its continued use has produced so extreme a degree of soil acidity that the land now grows practically nothing but spurrey.

The rapidity of action of artificial nitrogen fertilizers, as compared with organic manures, may be either an advantage or a disadvantage. Where a plant absorbs food over a period of many months it must be obvious that a single large dose of nitrate or ammonia will provide a temporary superabundance of nitrogen, with the risk of a scarcity later on. With wheat, for instance, an early spring top-dressing, alone, may be perfectly sound if the land has a good reserve of organic manure, which will continue to yield up nitrate throughout the summer. On the other hand, if the land is deficient in organic residues, a heavy spring top-dressing will produce a heavy growth of straw, but will not last out until the time of grain formation. In such circumstances it is an advantage to give the crop two "feeds"—one early and the other later (perhaps in May), after the ears have begun to form.

Something must be said about those forms of plant life which are independent of a supply of nitrates or ammonia in the soil.

On the one hand are those that are able to assimilate the

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free nitrogen of the air and convert it into proteins; this is a task that chemists are not yet able to accomplish. The most efficient nitrogen collectors are the yeasts, and those people who would propose to abolish farming altogether suggest that the manufacture of protein should be carried out by cultivating yeasts. Sugar can be made out of coal and water; a solution of sugar, with mineral salts, is all that the yeast requires to live on. It gets its energy by fermenting the sugar into alcohol, uses atmospheric nitrogen to build up its living substance, and multiplies very fast. Man would thus subsist on sugar instead of bread, dried yeast instead of beef, and would have, presumably, a superabundant supply of alcohol.

Another group of organisms can obtain their energy from starch or even cellulose, and again assimilate nitrogen from the air. *Azotobacter*, a species of bacterium, is the best-known member of this group, and undoubtedly plays a part in adding nitrogen to the soil; unfortunately it seems to function actively only when the soil nitrogen is at a low level, and it is doubtful whether much can be done to encourage it in its praiseworthy efforts.

Much more important is the well-known fact that the nodule-forming organisms of clover, lucerne, beans and other leguminous plants are able to fix nitrogen and pass this on to their hosts. It used to be thought that the enrichment of the soil itself took place only with the death and decay of the host plant, e.g., the clover root in a ploughed-out ley. Recently, however, it has been shown that the legume may, while still in active growth, excrete into the soil the surplus nitrogen compounds with which its nodule organisms have provided it. The nitrogen is given out as amino-acids, which are converted into ammonia in the course of a few days. We, in this country, are accustomed to make use of leguminous crops mainly in the form of their residues, e.g., to grow wheat or oats after clover; in tropical countries, on the other hand, the traditional practice is to grow the cereal and the legume in mixture; this is probably better, under warm conditions, than our plan, since in tropical climates the legume roots would often be rotted and gone before another crop could be established on the land. Even in this country there may be something to be said for mixed cropping as a substitute for nitrogen manuring; for instance, an experiment was carried out at Rothamsted some years back (*Roth. Ann. Report 1932*) in which the yields of pure oats, pure vetches and various mixtures of the two, with

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and without nitrogen fertilizers, were compared. Some of the results (in cwt. total dry matter per acre) were:—

	4 bush. oats.	4 bush. vetches	2 bush. oats 2 bush. vetches
Without nitrogen ..	42·9	28·6	48·9
With nitrogen ..	53·5	30·9	55·8

It is obvious that an acre of the mixture was much more productive than an acre divided equally between the two separate crops; and that the advantage of mixing was greater in the absence of nitrogen fertilizer.

On the other hand is a group of plants which can “digest” dead or living organic matter in somewhat the same way that it is digested by animals. The growth of mould upon cheese, of the blight fungus on the potato leaf, and of the mushroom on a heap of horse-dung, are examples of this mode of feeding.

Here again there is an interesting case of co-operation or *symbiosis* between lower and higher plants. On sour peat land there is very little bacterial activity to bring about the decay of the organic matter, and the ordinary plant suffers from the lack of available nitrogen. The plants that live in such conditions do so by reason of the fact that certain fungi live on their roots, and make it possible for the roots to get nitrogen direct from the dead organic matter. Best known among these plants are the heaths and rhododendrons, many of which have become completely dependent upon their root-fungi; if they are planted in ordinarily limey soil the root-fungi are killed, and the plant itself perishes soon afterwards, being unable to make do with nitrate.

In most systems of agriculture the farmer relies largely, for the maintenance of the fertility of his soil, upon organic residues—roots, stubbles, beet-tops, ploughed-in turf, dung and other organic manures. Part of the value of all these things lies in their nitrogen content, the nitrogen being freed, as nitrate, during their decay in the soil. Sometimes the object of the farmer is to speed up the rate of decomposition of organic matter, as when he is reclaiming a peat soil or is turning straw into manure; sometimes his main concern is to retard the processes of decay, as when he is storing cake-fed dung; sometimes, again, he wants to prevent decomposition, as in hay-making, ensilage or other methods of food conservation. From all these points of view we must try to understand the changes to which organic remains are subject; these will form the subject of the next article of this series.

THE MANAGEMENT OF CENTRAL APPLE- PACKING STATIONS

CLIVE BURTON

General. The first concern of the management of a station is actually the contracting farms. It is essential to ensure that only growers who are carrying out an effective spraying programme and generally running their farms on efficient lines, are admitted as senders of fruit. The unremunerative prices obtained for low grade fruit will not warrant packing and marketing charges. This fact is clearly brought to light in a packing station's returns, but in the accounts on many farms which carry out their own packing and marketing operations it is very largely hidden under the vague term "General expenses."

Every member sending fruit to a packing station must realize that packing cost depends upon the station's output of graded apples. In the attainment of a high output, efficient management is only one factor; an equally important one is the quality of the fruit received. Fruit requiring a lot of grading and fruit with a high proportion of small apples so interferes with output that the actual cost of handling is out of all proportion to the value of the fruit. The manager must pay several visits to the farms during the growing season to advise on thinning and to assess the quality of the fruit.

Members must accept the decisions and recommendations made by the Management Committee, which will also deal with any complaints. Every member, however, should always be welcome to inspect the packing house and grading operations at any time.

Picking. More rapid handling, and in consequence, lower costs will be attained when growers realize that grading commences at the tree. When trees are stripped and every apple is sent to the station unnecessary expense is caused. When there is a full crop, several pickings should be made so that in the first instance only well coloured, good sized fruit is gathered.

At picking time a great deal of damage is caused through overlooking minor points. Pickers should be inspected for

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shortness of finger nails—some growers issue picking gloves. Growers must insist that only sound fruit is picked, and picked correctly, any fruit showing the slightest sign of rot or bird pecks being discarded or placed in a separate basket. This point must be stressed because in a rush period the apples may have to be placed straight into store before they can be handled. Very slight injuries at picking time develop rapidly into advanced rots which may contaminate the neighbouring apples and so cause serious loss.

It is worth while for the manager to see and advise upon roads, loading bays and farm carts. For orchard carts low pressure pneumatic tyres are best. Just as damage to the fruit can be avoided by careful picking so it can be avoided by careful handling and transport. Loading time of lorries can be saved in many ways; for example, a dump can be arranged adjacent to a hard road with a loading dock at the height of the floor of the lorry to facilitate loading. This ramp can be built up from rising ground or constructed as a wooden stage. Again, a few lengths of roller conveyor may save much unnecessary walking with boxes of fruit from dump to motor vehicle.

Estimates of Yield, etc. During the manager's summer visits, estimates will be prepared, in consultation with the growers, of the probable yields of each variety, and notes should be made relating to size and colour. This information is invaluable in arranging for long runs of similar fruit when packing commences.

Supplies. (a) *Orchard Boxes.* All orchard boxes should be clearly branded to show whether they belong to the station or the growers. It is essential that only clean orchard boxes should be used and all traces of leaves and rotten fruit should be removed. The boxes should be dipped into a solution of lime sulphur at about 5 per cent. concentration to ensure that all disease spores are killed.

Under ideal conditions, the station should own all orchard boxes, in spite of the considerable capital outlay involved. As most farms have a number on hand it may not be practicable for this to be attained for some time. It is essential, however, that any new boxes bought should be of a standard pattern. The stacking of even slightly different sized boxes, over 5 high,

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tends to damage fruit, wastes valuable space and is dangerous to workers.

(b) *Consumable Supplies.* Advantage can be taken in buying forward, when prices are favourable, such supplies as box wood and packing papers, which will keep for a long time without deterioration. The value of capital so locked up, however, must be considered when assessing price quotations. The most attractive prices are often to be found before the coming crop can be properly estimated. On the other hand, if supplies are bought only in small quantities as and when actually needed, difficulty may be experienced in delivery, and in a year of heavy crops prices may have hardened considerably.

Staff. The packing-house manager must keep a list of workers and should see that enough workers are available to handle the maximum load. Where new packers require training, the best time to carry it out is during the early apple season. Where the staff is inadequate to conduct the teaching, help can be secured usually from the County Department of Agricultural Education or from the Ministry of Agriculture and Fisheries.

Particular attention must be given to selecting the right people for the key posts of foreman and forewoman. While the latter will be responsible for the supervision of grading and packing, the foreman should be able to oversee this department in her absence, because supervision must be constant. Unless the size of the station justifies the employment of a full-time mechanic, the foreman should be able to undertake the running care of power, grading and refrigeration machinery. The essential duties of the supervisory staff must be carefully and clearly defined. For example, there must be an inspection of every box before lidding, and where control is divided it is necessary to see that a deputy carries out this duty when the main supervisor is otherwise occupied.

A long packing season is possible only where ample gas-storage accommodation is provided. In order to reduce standing charges and give the key employees work all the year round, it would be an advantage for some secondary activity to be undertaken. Up to the present, box-making is the only such activity suggested that does not require considerable additional capital or the utilization of space required during the packing season.

It has been found from experience that when 8 or 9 months'

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employment can be offered to women, they are prepared to stand off for the rest of the year and return the following season. In the peak of the season the semi-permanent workers can help supervise the new and temporary recruits.

The diversion of female labour from packing stations to farms or vice versa has not been successful because the type of woman who has sought employment in a packing station differs from that which accepts work on the land.

It is not always practicable to rely upon farm labour to supply the proportion of male labour necessary for filling gas stores, moving boxes, etc. On the other hand, it is quite feasible for the packing station to have a permanent gang of men on its books, who can be hired out to the farms when not required for packing-station work. This system has been used and has proved excellent in every respect. This gang should be a self-contained unit under an expert fruit foreman, with its own transport facilities, such as an old car or lorry, and its work would consist of pruning, spraying, grafting, etc. It has been found that such a supplementary labour force is in keen demand by fruit growers during the period when the packing station is not fully occupied.

Packing Organization. (a) *Delivery of Fruit.* Growers should be given as much notice as possible relating to the amount and variety of fruit they should have ready for collection, in order that they can make adequate arrangements for picking. The delivery of fruit to the packing station is, in some instances, arranged by the grower. To save congestion and ensure more even supplies, it is better for the management to control the collection.

(b) *Temporary Storage.* The design of central packing stations has been dealt with separately.* One factor, however, needs emphasis as it assists materially in maintaining quality and condition and in spreading the flow of apples evenly, both from the orchards and to the markets. This is the desirability of having cold storage space sufficient for a large proportion of apples not marketed immediately or placed in gas store. Cold storage room equal to one week's load at maximum packing capacity is probably the minimum. This provides a controlled low temperature store for excess deliveries, for building up a reasonable run of one variety, for reserves to allow for

* Notes for National Mark Apple Packers No. 16.

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deficient deliveries due to bad weather and for the temporary holding of packed fruit of varieties not gas stored. The use of a cold stored, packed reserve is particularly useful during the period when the gas stores are being filled.

(c) *Reception.* The fruit arriving at the packing station is delivered into the reception bay for immediate packing or is diverted to temporary storage. In either instance a particular day's consignment of any one variety from an individual farm should have a notice, such as a cardboard or slate, attached stating the date of arrival, the number of boxes, the variety and the owner. This information should also be entered into the reception day book and the grower's invoice should be checked and countersigned by the man in charge. Empty orchard boxes should be under the charge of either the reception clerk, or dispatch bay man who should issue an invoice for every load of boxes taken back to the farm.

(d) *Cull Removal, Grading and Packing.* Sufficient fruit of one variety from one farm should be allowed to accumulate in order that the grading and packing staff can have a steady run of work for several hours. Before going over the grader, each consignment should be examined by the manager and/or forewoman to decide upon any necessary instructions for the sorters and packers. This examination is very important in the maintenance of uniformity in the packed apples.

The fruit should first pass through a Cull Eliminator to remove leaves and very small apples. For this machine several belts with various sized holes are necessary. During last season, 2 in. holes were used for dessert varieties, thus allowing $1\frac{3}{4}$ in. apples to drop through. In a year of heavy crops, and for cooking varieties, belts with larger holes are required. The apples that drop through should be kept off the wholesale markets and be disposed of for by-product manufacturing purposes.

It is a good policy to concentrate on a very high colour standard for Extra Fancy grade. With Worcesters and other highly coloured apples, an apple less than 50 per cent. fully coloured red in one solid area should go into a lower grade than Extra Fancy, however perfect it otherwise appears. For Fancy grade, 25 per cent. solid colour should be the standard. With Cox's, two Extra Fancy grades may be used, i.e., full colour Extra Fancy, and plain Extra Fancy. Although extra money may not be received, the idea appeals to buyers as some require a highly coloured Cox and others an almost green

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Cox. Where only a four-track grader is available, colour grading is difficult because bins normally used for low grades will be required for one of the colour grades, and low grade fruit must therefore be picked off the sorting belt and put into some form of container. Where the proportion of low grade apples is high, this removal may be impracticable.

(e) *Inspection, Stamping and Lidding.* Weights of boxes should be checked to see that the buyer is getting the correct amount of fruit and that the Station is not losing fruit by giving over weight with excessive bulges. The main work of the forewoman consists of inspection of grading and correctness of pack. She must also be responsible for seeing that each box is correctly marked as regards the grower's identification. It is probably desirable that all stamping should be under her supervision, although occasionally it is done by someone working with the ladder.

(f) *Dispatch.* Dispatch bay organization calls for considerable care to secure efficiency. At some stations a tally of each box is made as it passes from packing room to dispatch bay, at which point the identity of the owner is lost. At other stations, the fruit from different farms is kept in separate stacks until a tally has been made on completion of a particular lot. As the growers' grading returns are obtained at this point, it is highly desirable to have some cross check, which is best obtained on loading for market, by entering on the copy of the advice note kept by the station, the code letters relating to the farms which supplied the fruit in the consignment. The fruit, however, is sold under one common brand, and the consignments are made up of counts or grades to suit particular markets.

(g) *Managerial Control.* A central packing house will be judged on two things, the efficiency of its grading and packing and the cost per bushel. A good manager will see that as far as possible every routine job is delegated so that he is able to concentrate on these important matters. It is a task demanding constant vigilance. Every drop in output and every market complaint requires the most minute investigation. Particular attention should be given to fruit being received, in order that the growers can be kept informed of directions in which their activities can improve the efficiency of the station.

In the end it is the sorting and packing staff which is the mainspring of the packing house. Every possible means must be adopted to ensure individual efficiency. Good

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packing is not a mechanical operation and both intelligence and experience are required. The skill of sorters and packers must be developed and their interest maintained and the manager who makes a careful study of these factors will be amply repaid.

(h) *Costs.* Since a really accurate system of costing is impracticable for small organizations like existing central packing houses, it is useful for the manager to make occasional time studies of items not accurately costed in the office system.

It is necessary also to inculcate in the grower-members that their indebtedness to the station is not measured by the number of boxes packed for them, but by the station time occupied. The sender of culls soon realizes this if a flat packing rate is charged on all fruit *marketed*, and the money realized for low-grade fruit sold for by-product manufacturing is retained by the station to offset general running expenses.

CROSS BREEDING WITH PIGS

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What are the comparative merits of pure and cross-bred pigs for commercial purposes? Widely differing opinions are held on the subject by pig breeders, and an experiment is at present in progress at Wye designed to obtain definite data. The problem is complicated and it must of necessity take a considerable time to obtain information upon the numerous issues involved, but in the first stage, which was completed in the years 1935-38, data of value to practical pig-keepers was obtained and is summarized in this article.¹

Two breeds of pigs, Large Whites and Saddleback (Essex), are kept in the herd, and during the years 1935-37 each sow reared a pure-bred litter and a cross-bred litter alternately. Thus the four following types of pig have been produced:—

1. Pure Large Whites.
2. Cross breds from a Large White dam and a Saddleback sire.
3. Cross breds from a Saddleback dam and a Large White sire.
4. Pure bred Saddlebacks.

The litters were grouped in lots of four. Every lot contained one litter of each of the four types, and the four litters in a lot were treated as nearly as possible alike from birth until the pigs reached the bacon factory. Further, no litter was included in the figures unless the dam reared two litters, i.e., one of pure-bred pigs and one of cross breds. Fifty-six litters were secured in the first stage, i.e., fourteen of each type.

Litter Averages. The sows and their litters were kept on the indoor system and the piglings, weaned when eight weeks old, were not forced.

Significant differences were obtained in the mortality amongst the piglings of the different types. Table I gives the litter averages to weaning for Large White and the Saddleback sows:—

TABLE I.—LITTER AVERAGES OF LARGE WHITE AND SADDLEBACK SOWS
(AVERAGE 28 LITTERS)

	<i>Large White Sows</i> (per litter)	<i>Saddleback Sows</i> (per litter)
Born	10.3	10.3
Weaned	9.0	9.5
<i>Average Weights :</i>	(lb.)	(lb.)
Per litter	256	269
Per pig	28.4	28.1

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The figures show that both types produced satisfactory litters, but the mortality amongst the progeny of the Large White sows was slightly higher than that amongst the progeny of the Saddlebacks. This was reflected in the total weight per litter, as there was no appreciable difference in the average weight per pig.

The detailed figures¹ show that the mortality amongst the progeny of the Large White sows occurred mainly in the pure-bred litters. These sows can be divided into two classes. The sows of Class I, which may be described as "good rearers," produce large litters amongst which the mortality is negligible. The sows of Class II, which may be described as "moderately good rearers," produce large litters amongst which the mortality during the nursing period is liable to be comparatively high. The mortality amongst the piglings of Class II was reduced to a material extent by crossing them with a Saddleback boar. This is clearly shown in Columns 1 and 2 of Table II, from which it will be seen that, whereas the mortality amongst the cross-bred piglings was on an average $\frac{1}{2}$ pig per litter, an average of two piglings per litter were lost in the pure-bred litters *from the same sows*.

TABLE II—LITTER AVERAGES FOR THE FOUR TYPES (AVERAGE 14 LITTERS)

	1	2	3	4
<i>Sow</i> ..	Large White	Large White	Saddleback	Saddleback
<i>Boar</i> ..	do	Saddleback	Large White	do
	<i>per litter</i>	<i>per litter</i>	<i>per litter</i>	<i>per litter</i>
<i>Born</i> ..	10.3	10.3	10.5	10.2
<i>Weaned</i> ..	8.3	9.8	9.3	9.7
<i>Average Weights</i>	(lb)	(lb)	(lb)	(lb)
<i>per litter</i>	228	285	266	271
<i>per pig</i>	27.5	29.2	28.5	27.7

Not only was the mortality amongst the cross-bred piglings lower than that of the pure breds, but the surviving cross breds made better growth than their pure-bred mates. The net result was that the cross-bred litters were on an average 59 lb. per litter heavier than *the pure Large White litters from the same sows*.

It is notable that the mortality amongst the cross-bred litters reared by the Saddleback sows was slightly higher than that amongst the pure-bred litters from these sows (Table II). The difference was, however, comparatively small and was balanced by the fact that the cross breds made a little more growth than the pure breds.



FIG. 1. One of the Saddleback (Essex) Boars used as a Sire.



FIG. 2. The Gilts from which all the Large White Sows were descended.

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The degree of uniformity which exists in a litter of pigs is almost as important as the average weight. Are the pigs in a cross-bred litter as uniform in size as those in pure-bred litters? It is necessary to make the comparison between litters from the same dam which contain as nearly as possible the same number of pigs. An analysis of the litters farrowed during the three years under discussion yielded twenty pairs which were comparable.¹ The pure-bred litter was found to be more uniform than the cross-bred litter in twelve of these, whilst in the other eight the reverse was the case. The differences between comparable litters from the same sow were, generally speaking, small, whereas there were very appreciable differences in the degree of uniformity of the litters from different sows.

The Effect of Crossing on the Carcass. A proportion of the pigs from each litter was finished as Class I bacon pigs on a standard system of feeding. They were sent to the factory when they had an average carcass weight of as nearly as possible 150 lb. Four pigs were selected from each litter for comparative purposes, and the grading on the 1939 standards² of the forty-eight pigs from twelve litters of each type is given in Table III.

TABLE III — GRADING OF FORTY-EIGHT PIGS OF EACH TYPE

				A	B	C	F
Large White pure	..	.	..	39	7	2	—
Large White sow	Saddleback boar	..	..	36	9	3	—
Saddleback sow	Large White boar	..	..	34	9	5	—
Saddleback pure	..	..	..	29	14	4	I

It will be seen that the pure-bred Large White pigs graded slightly better than the cross breeds from the same sows by a Saddleback boar, whilst the cross breeds from Saddleback sows by a Large White boar graded better than the pure-bred Saddleback pigs, though in both instances the difference was small. There was no appreciable difference in the thickness of the back fat over the shoulder in the four types, the differences in the grading being entirely due to the thickness of the fat in the middle of the back.¹

Meal Consumption. The figures for the two years do not reveal any significant differences in the meal consumption of

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the four types. The averages for a batch of sixteen litters are given in Table IV.

TABLE IV—MEAL CONSUMED PER 1 LB. LIVE WEIGHT GAINED.

		<i>Meal consumed per 1 lb. gained</i>
Between weaning 29.2 lb and bacon weight 198 lb. . .	(SEM 0.04)	3.84 lb.
„ 63.9 lb. and bacon weight . .	(SEM 0.06)	4.03 „
„ weaning 29.2 lb. and 63.9 lb. . .	(SEM 0.006)	3.09 „

It will be seen that the amount of meal consumed per unit live weight gained increases as the pig grows. There are considerable differences in the weights at weaning of the pigs of different litters. Thus, if the amount of meal consumed per unit live weight gained is to be used as a standard of efficiency it should be calculated for the same stage of growth, i.e., between the same weights, for the pigs which are to be compared. The figures in Table IV show that the litters which have the highest weaning weight will be penalized if the meal consumption is calculated from weaning.

Climatic conditions at Wye are liable to cause considerable variations in the amount of meal consumed per unit live weight gained at different periods of the year. Prior to the time the pigs are 60 lb. live weight the difference is insignificant, but it *may* be appreciable between 60 lb. live weight and bacon weight as will be seen from Table V, which gives the average figures for eight litters farrowed in December, January and February, and the succeeding litters from the same sows farrowed in June, July and August.

TABLE V.—MEAL CONSUMED PER UNIT GAINED BY SUMMER AND WINTER LITTERS FROM THE SAME SOWS

<i>Farrowed</i>		<i>Average Weaning Weight lb</i>	<i>Meal Consumed per Unit Live Weight Gained</i>	
			<i>Weaning to 60 lb Live Weight</i>	<i>60 lb. Live Weight to Bacon Weight</i>
Dec.-Feb. . .	(SEM)	28.7	3.11 (0.06)	3.83 (0.03)
June-Aug. . .	(SEM)	29.8	3.08 (0.06)	4.23 (0.006)

Summary. The results indicate that the mortality in litters from Large White sows may be reduced by crossing with a Saddleback boar; the cross breds from *such litters* make slightly more rapid growth during the nursing period than pure-bred pigs from the same sows.

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Mortality amongst cross bred from Saddleback dams by a Large White boar was slightly higher than amongst pure-bred Saddleback pigs from the same sows, but the difference was too small to have any practical significance.

Pure-bred piglings were slightly more uniform than cross bred from the same dams.

Cross-bred pigs did not grade as well as pure-bred Large White pigs, but graded better than pure Saddleback pigs; the difference was, however, comparatively small. There was no appreciable difference in the thickness of the shoulder fat of the four types, the difference in the grading being due to variations in the thickness of the fat in the middle of the back.

The figures for the two years do not reveal any significant differences in the meal consumption of the four types, but they show that if the meal consumed per unit gained is to be used for comparative purposes it should be calculated on a *weight not an age basis*, and that climatic conditions prevailing at different periods of the year may cause material variations in the amount of meal consumed per unit gained during the second half of the feeding period.

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THE CONTROL OF RABBITS

A series of field tests have recently been conducted by the Ministry over a period of about fifteen months with various types of traps and other devices used for killing or capturing wild rabbits, the object being to obtain wider information as to methods of control and, in particular, to find a more humane type of trap than those generally used, which would, at the same time, be no less effective. These experiments were undertaken in pursuance of a recommendation to that effect contained in the Report issued in 1937 by a Select Committee of the House of Lords on damage to agriculture by rabbits.

Rabbit-infested areas in various parts of the country were selected for the experiments in order to make the tests under widely differing conditions. The work was much facilitated by the willingness of certain landowners to allow their land to be used for the experiments, or for observation, and by the generosity of manufacturers and others in supplying free, or at a nominal charge, various types of traps, appliances and material used in the destruction of rabbits.

The methods tested or observed included trapping, snaring, netting and gassing, and much useful information was collected regarding the conditions and circumstances in which any specific method might appropriately be employed, and the advantages or disadvantages of particular types of appliances, traps or gases.

It may be said at once that in the course of the experiments no single method was found to be entirely satisfactory under all conditions. Gassing, for instance, was found to be of little use in light, dry sandy soils owing to the runs in the rabbit warrens failing to hold the gas. Early spring is generally the most suitable time for gassing rabbits as the soil is then moist and the rabbits are in winter quarters and breeding is in progress. One difficulty as regards gassing is that rabbits rarely attempt to bolt, but are more likely, especially if the operations are attended with much noise, to bunch or pack themselves in the extreme ends of burrows with their noses together. The rabbits may thus remain unharmed by gas for considerable periods, and unless they can be dispersed by stamping on the ground or other means they may escape injury. It must also

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be remembered that digging will be necessary if it is desired to recover the bodies of gassed rabbits.

Gas, to be effective, should be as free from odour as possible and should be colourless, heavier than air, persistent and of rapid lethal power. Among the gases or vapour tried during the experiments were :—

Carbon-monoxide as generated (a) in a charcoal burning machine and (b) in the form of exhaust fumes emitted from an internal combustion engine. The former method was economical in cost of working and the latter proved effective and comparatively cheap.

Hydrogen cyanide as produced by the action in the rabbit burrows of the moist air releasing the gas from finely powdered material introduced by a machine. This gas is particularly dangerous and it is advisable that it should be used only by skilled operators familiar with the precautions necessary to be taken in its use.

Sulphur dioxide ("Clayton" gas) as generated by burning roll sulphur in a specially constructed machine.

Compound sulphurous gases as generated by burning "cartridges" in a special container.

*Carbon di-sulphide** vapour given off by sacks soaked in the liquid, and pushed down rabbit holes.

Acetylene as applied by placing calcium carbide*, which reacts with water to produce the gas, as far down rabbit holes as possible, damping the carbide and stopping up all connecting holes.

The results obtained from the use of these gases and vapours were not entirely satisfactory, mainly because in the early spring of 1938 the soil was abnormally dry, and in spite of a good rainfall during July and August the soil remained remarkably dry throughout the autumn of that year. The general conclusion to be drawn from the experiments with gas was that from the point of view of effectiveness there is little to choose between one form of gas and another, and it would seem that the determining factor must to a large extent be the cost likely to be involved by the use of a particular form of gas. There can be no doubt, however, that where an internal combustion engine, such as that of a car, motor cycle or tractor is available, gassing by means of the exhaust fumes is an economical method of ridding land of rabbits.

A few tests with nets were carried out, but none was found more effective than the ordinary long net with pegs in common use. Other nets were either too small for general use, or required careful setting up beforehand. In the hands of a skilled trapper, the common long net can be set many times in a night and is easily moved from one side of a field to another to suit

* Great care is necessary in using carbon di-sulphide and calcium carbide to avoid explosions by ignition. Operators should, therefore, refrain from smoking or lighting matches.

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the wind. After taking out the catch, the net can be used at once in another area where the rabbits have not been alarmed.

In the course of the experiments, various types of traps and snares were used, and 4,081 rabbits were caught by traps and 675 in snares. Of the number trapped, 1,765 were bucks and 2,073 does, the remaining 243 not being classified as they had been either damaged by predatory animals or stolen. It was possible to examine 4,001 of the trapped rabbits to note the effects of the trapping, and it was found that 1,098 had not sustained damage, while 2,903 had fractured limbs. Of the 1,098 found undamaged, 5 per cent. only were immature rabbits, whereas of the 2,903 rabbits that had limbs fractured, 2,141 or 74 per cent. were immature, thus demonstrating the much greater liability of young rabbits to suffer damage by trapping. This liability is due to the softness of the bones of immature animals. For this reason, during the spring when the rabbit population largely consists of young rabbits, gassing would doubtless prove more humane than trapping.

Experience has shown that to obtain satisfactory results from the use of traps, it is advisable to give attention to the following points:—

- (a) Remove all oil or varnish from newly-manufactured traps. This is sometimes effected by trailing the trap through soil behind a harrow for a sufficient distance. Another method employed is to wash the trap in commercial petrol and then boil several times in water and soda, afterwards burying in light soil for about 10 days, before finally allowing a slight coating of rust to form on it.
- (b) Shape the mouth of the rabbit burrow with a spade or rabbiting tool so as to permit the jaws of the trap to come underneath the overhanging entrance, and to a depth just sufficient to accommodate the set trap.
- (c) Set the adjusted trap in the prepared bed in the rabbit burrow so that it lies flat and rigid. Stake it securely, covering the spring, stake and chain with soil.
- (d) Spread sifted soil lightly over the plate and jaws of the trap by means of a stick. Care should be taken not to "taint" the soil by touching it with the hands.
- (e) Stop up all bolt holes.

It was found during the tests conducted that the best results were obtained by laying the traps before mid-day and paying at least two visits to the traps within twenty-four hours.

The general adoption of this procedure and the use of well designed traps of good quality would to a large extent ensure "humane" trapping, even with the traps which are now available. It is suggested that the cruelty associated with the taking of rabbits arises chiefly through the casual manner in

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which the devices now in use are operated. A certain amount of suffering is probably inevitable, but it would be reduced to a minimum if care were exercised in trapping. It should be possible for a good trapper with the use of 100 traps to average a catch of 400 rabbits a week on good trapping ground. Actually, it has been shown that a similar return from the use of inexperienced and often illegal methods and badly made traps may involve the use of as many as 1,000 traps.

Many of the trapping devices submitted for the field tests were found to have certain drawbacks as compared with the ordinary steel trap. They were, as a rule, more expensive and many took far longer to set, or required more care in adapting the burrow for their reception. Many, also, could not always be set to comply with the requirements of the Prevention of Damage by Rabbits Act, 1939, or were heavier than the ordinary steel trap. This latter point is important, as it reduces the number which the trapper can carry in the course of his work. One of the aims of the experiment was to find an improved trapping device which would minimize cruelty to the rabbit either by holding it painlessly (or with the minimum of pain) or killing it instantaneously without mutilating it.

One new trap submitted towards the end of the period of experiments gave promise of fulfilling these conditions as a "killing" trap. The time available and the severe climatic conditions did not enable exhaustive tests to be made by the Ministry.

The object of this new trap was to ensure if possible a humane "kill" either as the rabbit entered or left the burrow, but further field tests over a period would be necessary to prove whether the trap is entirely satisfactory. It is understood that the Royal Society for the Prevention of Cruelty to Animals is much impressed by the results obtained with this trap and is making further tests thereof to ascertain whether it can be regarded as a humane device.

Tests were carried out with a number of other snaring devices in an attempt to find an alternative to the ordinary wire snare, which has certain disadvantages, being highly susceptible to frost and consequently becoming very brittle, resulting in loss of rabbits and wires. The ordinary wire snare may be set in the open and is not restricted by law for use in rabbit holes as is the spring trap. Most of the snaring devices tested were either too costly, too cumbersome or were otherwise not completely successful. One new snare, however, killed quickly

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without causing the rabbits to struggle, or to have a swollen or distorted head. The snare in question seldom failed, and being light and easy to transport, it gives promise to be an improvement upon the snares at present on the market. The Royal Society for the Prevention of Cruelty to Animals is fully informed of this snare and, having tested it, is prepared to recommend its use for catching rabbits humanely.

It may be mentioned that the Select Committee to which reference is made in the first paragraph of this article expressed the opinion that a trap which might prove to be equally effective but more humane than those in use was one having rubber jaws instead of steel teeth. This point was carefully investigated in the course of the experiments, but it was found that rubber jaws are chiefly objectionable on account of the odour which can never be entirely concealed from the rabbit's keen olfactory sense. Moreover, the mass of rubber necessary to ensure a satisfactory cushion would require a much more powerful spring than that usually fitted to a trap if speed of action is to be maintained. Further, the rubber itself under exposure to atmospheric conditions would not be likely to maintain its resiliency over an appreciable period of time. From actual experiments it was found that the grip of a rubber-jawed trap which would be sufficiently secure to hold struggling rabbits under all conditions would certainly not be more humane than that of well designed jaws fitted to the ordinary steel trap. Various tests made with human fingers showed that they could be held with complete security and with practically no pain in a steel jaw trap, whereas holding with the same measure of security in a rubber-jawed trap gave definite pain. On account of the flexibility of a rubber jaw it would be necessary to ensure a definite grip between the two faces, while with steel jaws it is possible to eliminate a grip, leaving only a gap of about $\frac{1}{8}$ in. between two fixed faces when closed which will rely upon the animal's knuckle or other enlarged joint to prevent withdrawal from the trap, incurring no uncomfortable pressure at the point where the jaws touch the leg.

It is above all necessary that the trap used should be efficient—the greater its efficiency, the greater the returns in actual cash value to the trapper. At the same time the suffering caused to rabbits caught by an efficient trap will be lessened because of the inducement to the trapper in his own interest to visit the traps more frequently, thus reducing the chances of rabbits escaping with mangled limbs.

METHODS OF SEED DISINFECTION

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Many of the diseases of farm crops are caused by microscopic organisms which are present on or in the seed, and it is these which are responsible for very considerable losses of farm produce. Some of these diseases have been known from early times and, as might be expected, numerous "cures" have been advocated for them.

In ancient and medieval eras—and in relatively recent times, too—numerous religious and superstitious rites have attended the sowing of the seed. This is not surprising, as on the outcome of the harvest, famine, pestilence or prosperity has depended. In antiquity, and as recently as the nineteenth century, god worship and superstitious practices based on this played a very important part in the cultivation of crops, and to propitiate the gods or spirits which were believed to control productivity, various offerings were made. These have included the sacrifice of both human beings and animals, and in many cases their blood or ashes have been scattered over the soil or mixed with the seed corn in the hope that fertility and abundance might result. In that long period during which the true nature of plant disease was not well understood, it is difficult to assess the progress which was then made in the conquest of plant disease, because "blighted" crops were attributed more to the displeasure of the gods, to witchcraft and the casting of the "evil eye," than to more mundane and material causes; nevertheless, even in those times certain farmers treated their seed corn before sowing.

In the sixteenth, seventeenth and eighteenth centuries numerous concoctions were used for steeping grain and various materials employed. These included alum, animal offal, arsenic, beef-broth, brimstone, claret, copper sulphate, dung, garlic, gypsum, lime water, plant ashes, salt, soot, sulphur, certain vegetable powders and urine. Many of the steepings contained numerous ingredients and various methods were devised to treat the grain. For example, Speed* suggested that

* SPEED, A. *Adam Out of Eden*. 1659. pp. 121-128.

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persons having much land should be provided with a "moat or standing pool" wherein might be thrown all manner of farm manure, especially rabbit dung, together with such oil, ale, perry, cider, beef-broth, etc., as could be spared, and also blood, urine and other waste. In addition to watering the land with this potent liquid by means of an engine "in part like that they use in London, when houses are on fire," Speed steeped corn in it for twenty-four hours and stated that one might expect better fertility and profit. Even in these times it is interesting to note that some of the preparations used were proprietary articles and were named after their maker. In contrast to these complicated steeps some advocated the brining of wheat, and this method received favourable comment from several of the earlier agricultural writers as it was stated to prevent "smut" in wheat.

Although the use of copper sulphate had been suggested in the eighteenth century as a means of preventing smut in wheat, it was not until the latter part of the nineteenth that it came into any general use. It is still used by some farmers for treating wheat, but it is regarded now as an old-fashioned and out-of-date method, because it has been superseded by more effective materials and better ways of applying them. One recipe for treating wheat in this way was as follows. The grain was placed in a heap on a clean floor and was sprinkled or sprayed uniformly with a solution of $2\frac{1}{2}$ lb. of copper sulphate dissolved in 10 gal. of water. Rather more than 1 but less than 2 gal. of this solution was required for every 4 Imperial bushels of seed. While it was being sprinkled, the seed was mixed thoroughly by continuous shovelling so that each grain became thoroughly moistened with a thin film of the solution. The grain was then raked out into a thin layer to dry it as rapidly as possible, and when dry it was sown. This process had a great disadvantage—it frequently caused serious injury to the germination of the wheat; moreover, it was not a suitable fungicide for oats or barley as the vitality of the grain was injured by such treatment.

The next advance after the introduction of copper sulphate was the use of formaldehyde, as disinfection with it was generally more complete and there was much less injury to germination. Formaldehyde is a gas and is sold as an approximately 40 per cent. solution in water, under the name of formalin. The dilution required was 1 pint of formalin to 40 gal. of water. As in the previous treatment the wheat was

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uniformly and carefully sprinkled or sprayed with the solution and constantly turned over and over during the process. From 1-2 gal. of solution was required to moisten 4 Imperial bushels, and care was taken to see that the liquid did not form pools under the heap. After the sprinkling and shovelling, the grain was formed into a heap, and was covered with sacks which had previously been wetted with the solution. This covered heap was then allowed to stand undisturbed for four hours, during which time the formaldehyde completed the disinfecting process. It was then raked out into a thin layer, dried as rapidly as possible and sown, at the latest within two days. It has already been mentioned that copper sulphate was not a suitable fungicide for oats or barley on account of injury to the germination of these grains. Formalin, however, if correctly applied, and provided that there was no considerable delay after treatment and before sowing, was an effective fungicide not only for bunt in wheat, but also covered smut in barley, and loose and covered smut in oats.

It is clear that there were several objections to these wet methods of treatment. The moistening of seed grain was a laborious and troublesome operation, whether sprinkling or steeping methods were employed, and it was necessary to dry the grain quickly and to sow as soon as possible, otherwise germination might be adversely affected. It is not surprising, therefore, that to overcome these difficulties dry powders were developed as seed disinfectants.

One of the first employed in this country was a finely divided basic copper carbonate which was used at the rate of 2 oz. per Imperial bushel of grain, and from 1923 onwards trials with this dust were made by several research workers. The treatment was carried out by churning the seed and powder together in a revolving barrel or drum; later, however, special machines were designed for this purpose. In 1924-26 trials with copper carbonate as a dust disinfectant for seed grain were made on the Cambridge University Farm. In these experiments the older, wet treatments were compared with dusts, and the latter were found to be satisfactory for wheat if it was not severely contaminated with bunt spores. In 1925, as it was considered that there were definite advantages in dusting seed grain in this way, a machine designed for this purpose was imported from the United States. It was power driven and was equipped with a suction fan to reclaim any excessive dust and to prevent this from escaping

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into the surrounding air. It worked well, and was subsequently used by the Farm Director, Mr. A. Amos, to dress seed wheat for dispatch to clients if they required such grain to be disinfected. The introduction of this machine, and its subsequent use, is probably the first record in this country of such a farm implement, and it is recalled because, together with the experimental work which was being done at that time by a well-known firm of seed merchants, it represents a practical endeavour to limit the spread of disease by the disinfection of seed before it is received by the farmer. At the present time in this country about 300 seed merchants now make a practice of disinfecting their seed stocks with the modern dry dust disinfectants and protectives. It must be admitted, however, that at that time relatively few farmers used copper carbonate, and their first introductions to dust disinfectants for seed treatment were proprietary articles which contained certain salts of mercury as their fungicidal basis.

Formalin, although an effective fungicide for bunt in wheat, covered smut in barley and smut in oats, did not give a satisfactory control of leaf stripe in barley and leaf spot in oats, and very frequently these diseases were responsible for very serious losses and were causing much concern to farmers. In the control of these diseases the new organo-mercury seed disinfectants were strikingly successful, and in addition gave good control of the covered smuts. In some cases, however, the control of oat smut was not quite as effective as a formalin treatment. Research was directed on this and considerable improvements were made. It is interesting to record that some years ago field surveys were made in Cambridge to ascertain the incidence and intensity of this disease. Numerous cases were found and in many instances twenty or thirty per cent. of the crops was smutted. It is a welcome sign, therefore, that in the past season a similar survey has shown the incidence and intensity to be very markedly less.

The introduction of these organo-mercury disinfectants and protectives is an advance of the greatest importance in the history of synthetic fungicides, and due credit for this development must be given to interested commercial firms, for it is very largely by their activities that this result has been obtained. At the same time it is not inappropriate to record that academic research has played its part in the initiation of the method and, to some extent, in its subsequent development.

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What is the nature of these proprietary organo-mercury seed disinfectants? The composition of them varies with the particular commercial product but the main ingredients are very finely divided inert mineral carriers or fillers, with which are mixed or impregnated small quantities of one or more organo-mercury compounds; an anti-dust, sometimes of an oily nature, and a dye are usually added. In certain products which have been widely used approximately 97-99 per cent. of the dust disinfectant consisted of the inert filler, and 1-3 per cent. only—and sometimes less—of the poisonous salt. It would, however, serve no useful purpose here to describe the particular types of mercury compounds which are used in the compounding of these dusts; moreover, the results from industrial research necessitate from time to time certain improvements in the composition of them. It is sufficient to say that these materials have been and are the subject of intensive researches by interested commercial firms. As these materials are registered trade products, it is not possible for a farmer to apply to his local chemist and ask for one of these seed disinfectants to be compounded for him. As the composition of these materials varies with the particular commercial product, it is clear that the question immediately arises as to which is the best seed dressing for a farmer to use. The answer must be given that the products on the market are on a competitive basis, and that there is no existing organization in this country whereby such materials can be tested officially; this, however, does not imply that trials have not been made or that there are marked differences in the fungicidal efficacy of the better-known dressings. If, however, a farmer has any doubt as to the efficacy of a particular dressing he can do no better than to seek the advice of the County Agricultural Organizer.

Apart from its general or specific fungicidal power, and the control which it gives of disease arising from the sowing of seed which is contaminated or superficially infected with disease organisms, a modern commercial seed disinfectant must be reasonably safe and practical for the operator to use, taking the usual precautions when dealing with a poison; further, possible risks of injury to the germination of the grain must be minimized. It is necessary, perhaps, to inquire a little further into such points because they are matters upon which the farmer makes inquiry. Admittedly the modern methods of dust treatment are very effective in disease control,

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but occasionally the practice is criticized on the following counts.

1. The treatment necessitates the purchase of a machine for treating the grain.
2. It involves recurrent labour charges for de-sacking, dressing and re-sacking the seed, and the cleansing of sacks which have held treated grain.
3. The disinfectant dusts are poisonous and consequently precautions must be taken when using them.

The first criticism is not a valid one, for there are on the market several relatively inexpensive types of machine which serve their purpose well and the upkeep of which is negligible; further, it is now the practice of many seed merchants to dress seed for their clients.

The second criticism cannot be considered a major one, as the recurrent labour charges are much the same as those involved in seed treatment with the older liquid preparations. The most cogent argument is that these dusts contain certain compounds which are poisonous and consequently the usual precautions in dealing with a poison must be observed. The manufacturers state that it is advisable to avoid inhaling the dust, and that the nose and mouth should be protected with a cloth or respirator. Also, that some products should not be handled with wet or moist hands and should not be allowed to come into contact with wounds or broken skin, as they have a vesicatory action. They state, too, that after the treatment has been carried out, any dressing remaining on the hands should be removed by rinsing thoroughly. Also, dressed seed should not be used for feeding purposes, and bags which have contained such seed should be shaken out or washed before being used for carrying fodder. If the machine used for the purpose of dusting the grain is not adequately dust-proof, or if the compound used is volatile, then it is clear that the operator cannot avoid inhaling some of the disinfectant dust and, consequently, if dust-proof conditions cannot be secured, masks or respirators should be worn. Any risk would be further minimized by carrying out the dusting operation in the open air and not in a closed barn or shed. The practice sometimes adopted of spreading the grain on the barn floor, scattering the powder over this and then turning the grain several times with a shovel is to be condemned, and similarly the practice, sometimes seen, of placing the grain and powder together in a sack and shaking the contents vigorously whilst holding the sack by the four corners. These practices are

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bad because the ensuing disease control is less effective, and the operator will inhale the dust particles. Surely if elementary precautions are taken by the farmer the dusting of the grain should be reasonably safe. When, however, this dusting operation is carried out for very extended periods—as by seed merchants—then the greater element of risk must be considered and all adequate precautions taken. If any of the above arguments which are sometimes advanced can still be considered valid ones, then an obvious corrective can be suggested, and that is a combined seed drill and duster, i.e., a machine that would dust the grain as it was being drilled. Some years ago a machine of this type was devised and it was used on a commercial farm in Cambridge.*

Another question occasionally asked is: Is there any likelihood of these dusts injuring the vitality of the grain? Experimentally, a characteristic injury can be produced by excessive over-doses, and under abnormal conditions; in practice, however, these conditions are unlikely to arise.

It should be noted here that one of the major disadvantages of the wet treatments was that the grain had to be sown as soon as possible after it was dry. With the dust treatments this does not apply and the grain can be stored; moreover, there is no risk of re-contamination. An important point is raised here as it marks the difference between the older methods and the new. Formalin is an excellent seed disinfectant but it is not a good seed protective. The two terms have not the same meaning. A seed disinfectant such as formalin has an immediate but no lasting value as it cannot give subsequent protection to the seed. A bunted sample of wheat may be carefully treated with formalin and if sown immediately a healthy crop will result; but if, after treating the seed, the sack be roughly handled, and the grain is thereby re-contaminated, disease will appear in the crop when the seed is sown. With the dust treatment this does not occur, as subsequent protection is afforded. A seed disinfectant such as formalin would be of little use in protecting healthy seed from soil organisms as it has no lasting effect, and if the conditions for the germination of the seed were adverse it would be in serious competition with various soil fungi. As an illustration of this the treatment of seed peas may afford an example, for in experiments made at

* LEAKE, H. M., and WESTON, W. A. R. DILLON. "Combined Seed Drill and Duster." *J. Min. Agric.* 1938, 45, p. 344.

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Cambridge the evidence indicated that for early sowings the application of a suitable seed protective was likely to result in an increased stand and yield of marketable pods, whereas for later sowings—when conditions for germination were better—the advantages of such a dressing were doubtful.

It is sometimes suggested that these dressings exert some stimulating action on the young seedling; there is, however, no reliable evidence of any such tonic effect. The better stands which often result from such treatment are to be attributed to the control of disease organisms.

Unfortunately among some farmers there is an impression that these new treatments are a cure for all ills to which corn is subject, and not infrequently complaints are made that after corn has been dressed disease has appeared in the resulting crop. This is often so, for these dressings will not ward off the rust, mildew or take-all diseases of cereals, and they will not control loose smut in wheat or barley. It should be made clear that these powders disinfect the *surface* of the seed and for a short while protect it in the soil, but after that the foliage of the young plant may be attacked by various disease organisms. For example, barley suffers from a disease known as leaf blotch, and this is sometimes confused with the stripe and net blotch diseases of that crop. Seed treatment will control both stripe and net blotch, as these are caused by fungi on or slightly penetrating into the seed coat, but it will not prevent leaf blotch, as this is not a seed-borne disease. It is, however, loose smut in wheat, and more rarely loose smut in barley, which perplexes the farmer, for he knows that these are seed-borne diseases and yet he obtains no control of them. What is the reason for this? Wheat, barley and oats are each attacked by two entirely different types of smut—covered and loose. In the cases of the three covered smuts, and also loose smut in oats, the seed is *contaminated* by spores which rest on the *surface* of the grain, and consequently the application of a suitable disinfectant will kill them and prevent these types of smut from appearing in the crop. As the healthy and diseased ears are harvested together it is clear that the contamination takes place in the threshing machine. With loose smut in wheat and barley the matter is entirely different because the grain is *infected* and the fungus spawn is deeply embedded *within* it. The explanation is this. At flowering time the spores from these loose smutted plants are carried away by the wind and some of

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them fall on to the flowers of the healthy ears. If conditions are suitable they germinate and produce spawn which enters into the developing grain. This, however, has no visible effect on the seed, which enlarges and ripens off in what appears to be a normal manner. Nevertheless, although these grains appear to be perfectly healthy they are infected within, and when sown will produce a smutted plant. It is sometimes asked if there is any simple way for determining these infected grains; unfortunately there is no simple method which could be put into practice. It is clear, therefore, that the external application of a seed dressing, in any of those ways which have been discussed, would not prevent this type of disease. This problem of control is a difficult one because it is necessary to kill the spawn within the grain, without destroying the vitality of the embryo. Although it is possible to do this by a suitable heat treatment, this is not practical for the average farmer to carry out, as the risk of injuring the grain is so great; moreover, in this country there is not very much information as to the reaction of the various varieties to this treatment, or to the injurious effects which might arise if treated grain was incorrectly dried and then stored for any length of time; but on these, and other matters connected with the problem of the prevention of loose smut, research is in progress.

From what has been said it might appear that the beneficial vogue of seed treatment is confined to cereals alone, but this is not so, for by these or other methods a wide range of seeds is now often treated prior to sowing. Again, it may have been inferred that the only seed protectives are of the organo-mercury type; there are, however, other fungicides which are used successfully against certain seed-borne diseases, and also as protectives against certain specific insect pests, but here any general description of these might be confusing. It is sufficient to say that our present-day seed protectives mark a great advance in the romantic history of the control of seed-borne diseases, and there can be but little question that slowly and surely the conquest of these diseases is being obtained. The writer is indebted to Mr. F. A. Buttress, Assistant Librarian, School of Agriculture, Cambridge, for interesting references, relating to methods of seed disinfection, which have been carried out in the past.

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Materials for the Hand Packing of Cream Cheese

The following has been contributed by Miss Dorothy V. Dearden, National Institute for Research in Dairying, University of Reading:

In this article a short account is given of some experiments to determine the suitability of different materials for packing cream cheese and their effect on the keeping quality.

Muslin, with an outer wrapping of some suitable material, has been accepted in the past as the usual wrapping for cream cheese, but observations in connexion with the National Mark Cream Cheese Scheme indicated that the inclusion of muslin as a wrapping material reduced the keeping quality. As a result of this, seven experiments have been carried out using the following wrappings and combination of wrappings. Aluminium foil A and B (gauge 0.009 mm. and 0.012 mm. respectively), tinfoil, cellophane, and a waxed box, were each used alone, and with a lining of muslin, with a lining of muslin previously boiled and with a lining of vegetable parchment paper. Vegetable parchment paper was used alone, with a lining of muslin and with a lining of muslin previously boiled. Aluminium foil C (gauge 0.009 mm.), described by the manufacturers as "wax backed with 20 grs. glascine paper," was used without any additional wrapping material. The tinfoil was British rolled, gauge 10, with the inner surface treated to prevent discoloration of the cream cheese by direct contact with the tinfoil. The vegetable parchment paper was approximately 19 pounds per ream of 20 by 30 in. The cellophane used was moistureproof and colourless.

Method of Making. The cream cheese was made from cream which, after pasteurization, had been ripened by starter for 5-6 hours at room temperature. The temperature used for pasteurizing was either 170°F. with 5 minutes' holding or 160°F. with 10 minutes' holding.

After the ripening period, salt was added in the proportion

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of 1 oz. to each gallon of cream. Following 18 hours storage at 45°F., the cream was ladled into cloths laid on racks and allowed to drain until firm enough for packing.

Packing. When sufficiently firm, the cream cheese was packed in 2-oz. portions. Each wrapping was done in triplicate to provide samples having unbroken wrappings for three examinations at intervals of approximately a week. The observations have therefore been made on 21 samples of each wrapping.

Hand packing only was possible so that the suitability of these wrappings for use with machinery has not been considered. During packing, the ease with which each material could be handled and resist injury was noted. Tinfoil and aluminium foil wax backed with glascine paper were easy to handle and wrap. Both packages, though slightly different in colour, were attractive. Aluminium foils needed care in handling to avoid injury to them. When an inner wrapping material was used with these foils, the ease with which packing could be done was increased. The appearance of these packages was not unattractive even though the foils became crinkled. Cellophane was difficult to manipulate and the use of an inner wrapping did not tend to facilitate packing as with the metal foils. The appearance of the package when Cellophane was used alone was more attractive than with an additional inner wrapping material. Vegetable parchment, used separately or as an under wrapping, was easy to handle but, compared with metal foils, it was difficult to make a neat package and obtain close contact with the cream cheese. The waxed box was a very easy, labour-saving method of packing, but it was difficult to fill so as to obtain sufficient exclusion of air to prevent mould growth. The finished package was attractive and the rigidity of the box gave additional protection to the cream cheese.

Storage. Storage of the experimental cream cheese was done at room temperature.

Unwrapping. When unwrapping the samples for examination of keeping quality, note was made of the ease with which this could be done and of the appearance of the cream cheese after unwrapping.

Aluminium foils A and B became friable and tended to tear

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when unwrapped. Aluminium foil C was easy to unwrap, and any pitting of the foil which did occur had no deteriorating effect on the cream cheese as the glascine paper remained intact. Tinfoil was also easy to unwrap. The cheese, when unwrapped from either tinfoil or aluminium foil wax backed with glascine paper, were attractive, though differing in appearance in that a slight adherence of the tinfoil gave a rough surface, and the glascine paper lining of the aluminium foil, which did not adhere, left the surface of the cheese smooth.

In several instances the inner surface of the Cellophane separated and adhered to the cheese, giving it a highly glazed appearance.

The cheese unwrapped from parchment had a dried appearance and lost the characteristic texture of cream cheese.

Keeping Quality. After unwrapping, the samples were examined for growth of mould and then tasted. Marks were given to indicate the comparative growth of mould; the percentage of marks obtained by the various packings is given below. It is of interest to note that the third sample of four of the seven batches packed in glascine-lined aluminium foil was perfect on examination after 22 days storage at room temperature.

		Alone	With an Inner Wrapping of :		
			Muslin	Muslin, Boiled	Parch- ment
Aluminium foil A	..	79.3	40.5	40.5	22.2
" " B	..	82.5	35.7	38.0	23.3
" " C	..	88.8	—	—	—
Tinfoil ..	..	84.1	42.0	42.8	—
Cellophane ..	..	77.7	36.5	36.5	27.7
Waxed box ..	..	42.8	23.0	26.4	31.6
Parchment ..	..	66.6	63.6	68.3	—

It is clear that the inclusion of any material as a separate inner wrapping, whatever material was used as the outer wrapping, encouraged mould growth and thereby reduced the keeping quality of the cheese. This was no doubt due to an increase in the amount of air on the surface of the cheese, for it was noted with wrappings such as tinfoil and aluminium foil wax backed with glascine paper that, when mould was found, it occurred at points where close contact of the wrapping

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material and the cheese had not been obtained during packing. Bearing on this is the shape of the package. In these experiments a rectangular package was made: with this shape it is possible to obtain closer contact between the wrapping material and the cheese than when the shape is round.

Though little difference in flavour could be detected between the cream cheese taken from foil wrappings, preferences were expressed in favour of those from glascine-lined aluminium foil and tinfoil. Undesirable flavours were frequently noticed in the cheese packed in Cellophane: this was probably due to the action of light as no precautions were taken to exclude it.

Conclusions. A separate inner wrapping, such as muslin, reduces the length of time for which cream cheese will keep.

The glascine-lined aluminium foil and the tinfoil were the best wrapping materials used in the experiments.

Agricultural Education Association Conference

The Annual Conference of the Agricultural Education Association was held this year in the Agricultural Department of Queen's University, Belfast. Delegates were welcomed on arrival by the Vice Chancellor, and the Government of Northern Ireland gave a dinner at which Sir Basil Brooke, the Minister of Agriculture for Northern Ireland, presided. The Northern Ireland Prime Minister, Lord Craigavon, and the Minister of Labour were also present.

Lord Craigavon said that his admiration for the farming class increased every year, and he was glad to have the opportunity of expressing the Government's appreciation of the work of the Association, for he felt that the value of research work in farming was not always properly understood.

In his reply, Mr. W. B. Mercer, Chairman of the Association, referred to the remarkable results brought about in Ulster in a very short time in the fields of both research and administration.

Sir Basil Brooke said that in Ulster there are more farmers than in the whole of Scotland. He referred to the milk scheme in Northern Ireland, under which the consumer received the cheapest milk supply in the United Kingdom, whilst at the same time the farmers obtained as good a price for their liquid milk as in England or Scotland. Ulster was now producing one-third of the total United Kingdom output of bacon and

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hams, whilst the second quality egg, under the egg marketing scheme, had practically disappeared.

During the Conference, numerous topics dealing with agricultural education, research and administration were discussed at general and sectional gatherings. Excursions were made to the Plant Breeding and Veterinary Research Departments at Stormont, the Agricultural Research Institute and demonstration farm at Hillsborough, and to farms of the Irish Peat Development Company at Maghery.

In a paper on the Flax-growing Industry, Mr. W. J. Megaw said that it was most important in the national interest to keep alive the art of growing and handling flax. The minimum acreage which should be grown in peace time to provide some margin of safety was 50,000 to 60,000 acres, but to make this possible growers must be ensured of a remunerative price. He thought that a Flax Board should be constituted for this purpose.

Mr. J. Morrison gave a general account of the farming of Northern Ireland, stating that over 80 per cent. of the holdings are less than 50 acres in extent, and that probably not more than 20,000 agricultural labourers are employed. The potato crop accounted for approximately 64 per cent. of the total income from field crops, whilst recently there had been developed a considerable export trade in fat cattle. Professor R. G. Baskett described experiments in the feeding of large quantities of maize meal to bacon pigs, and came to the conclusion that a ration including up to 60 per cent. de-germed maize meal would give a reasonably firm backfat, but would impair the grading of the carcass. In a paper read in his absence Mr. James Mackintosh recommended the feeding of less protein to dairy cows; he suggested as a safe standard 0.5 lb. protein equivalent per 10 lb. of milk of average quality, instead of the 0.6 lb. now recommended.

Marketing Schemes in Northern Ireland were described by Mr. D. A. E. Harkness, and Dairy Produce Marketing in England and Wales by Mr. F. C. White of the Ministry of Agriculture. Mr. J. Getty described the schemes of agricultural education now being carried through in Northern Ireland, and a paper by Mr. S. J. Wright had some stimulating things to say about the teaching of agricultural engineering. He thought that possibly the most useful piece of equipment would be a two-seater tractor on which students could sit so as to see with their own eyes just what was going on.

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Grassland problems were discussed by Professor S. P. Mercer. He described wild white clover as a good servant but a bad master, and suggested that the despised Yorkshire Fog grass might be worth investigation, for it possessed certain qualities that made it useful in areas of low fertility. He favoured shorter leys combined with August sowings, and claimed that rushes could be eradicated to a very considerable degree by mowing at the right time of year. The effect of smoke on vegetation was described by Mr. Trefor Jones. Most of the damage was done during the winter months, he said, grassland and winter crops like wheat and winter vegetables suffering most. Spring-sown crops survived fairly well, but it was unsafe to spray potatoes with copper preparations even under conditions of mild pollution. The problem of the burning colliery refuse heap was a difficult one, but it might be solved to some extent by tipping waste material into derelict pits, as was now being done in certain parts of the Continent.

Dr. H. H. Corner described how "Pine" disease in sheep may be easily and cheaply controlled by the addition of small quantities of cobalt to the diet. A new method of testing the efficiency of seed disinfectants within a few days was explained by Dr. Muskett, and Dr. J. Carroll and Mr. R. Chamberlain dealt respectively with Eelworms in Eire and the Chrysanthemum Midge in Northern Ireland. Peatland reclamation was described by Mr. J. C. Baird.

These papers will be printed in full in *Agricultural Progress*, the Journal of the Agricultural Education Association, which appears twice yearly.

(D. H. Robinson)

Fertilizers in Modern Agriculture.

Readers will welcome the publication of a new edition* of Sir John Russell's monograph "Fertilizers in Modern Agriculture."

In this largely re-written edition the latest experimental evidence has been drawn upon and Sir John has been able to simplify the tabular matter and to deal more precisely with certain questions than was before possible. More information has been given about the manuring of market-garden crops,

* Bulletin No. 28, *Fertilizers in Modern Agriculture*, 3rd, rewritten edition. Obtainable through a bookseller or from H.M. Stationery Office, price 4s. (post free 4s. 6d.).

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and a new chapter has been added on a fresh subject—the effects of certain elements needed in small quantity only.

The aim of the bulletin is to summarize and place before farmers in a readily understandable form the lessons to be learned from experiments with fertilizers, and their applications in every-day farm practice. The main part of the monograph deals with the three groups of fertilizers—nitrogenous, phosphatic and potassic—and discusses the properties of the various manures included in these groups, their interchangeability and their suitability for the different crops as demonstrated by experiments conducted in Britain, on the Continent and elsewhere. Later, suggestions are made for the systematic manuring of all the ordinary crops, and the new concentrated complete fertilizers are discussed.

Marketing Notes

Livestock Industry Act, 1937: *Slaughterhouse Schemes.* With reference to the note in the March issue of the Journal on this subject, the Livestock Commission have decided that, subject to modifications in detail, the proposals of the Edinburgh, Leeds and Leicester corporations for establishment, equipment and management of slaughterhouses are, of the applications submitted to them, the most suitable for the experiments envisaged in Part V of the Livestock Industry Act.

Poultry Industry Bill. This Bill, which was withdrawn from the House of Commons on June 15 and presented to the House of Lords, received its Third Reading and was passed by the House of Lords on July 19. The Bill has since been reintroduced into the House of Commons and received a First Reading on July 21, but, as announced by the Prime Minister in the House of Commons on July 19, further Parliamentary consideration of the measure is to be postponed until after the summer recess.

Marketing of Milk Products: *Scheme under the Agricultural Marketing Acts, 1931 to 1933.* The draft Scheme for regulating the marketing of milk products, as modified by the Minister of Agriculture and Fisheries and the Secretary of State for Scotland, was laid before both Houses of Parliament on July 13, 1939, and resolutions of approval of the Scheme were passed by the House of Lords on July 26 and by the House of Commons on August 1.

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Following the approval of the Scheme by Parliament, the Ministers made an Order under Section 1(8) of the Agricultural Marketing Act, 1931, bringing the Scheme into operation on August 3, 1939. The Scheme provides for regulating the marketing of the following milk products produced in Great Britain—butter, cheese, condensed milk, condensed skimmed milk, dried milk, dried skimmed milk, cream and sterilized cream.

The Scheme now enters a "suspensory period" during which polls will be taken of the registered producers of each regulated product to determine whether or not the Scheme shall apply to that particular product. Unless a two-thirds majority of the producers voting, both as regards the number of voters and the quantity of the product which they are capable of producing, is in favour of the Scheme applying to the product concerned it will not apply to that product. Forms of application for registration will be published and issued to those known to be concerned. Only those who register before the date determined by the Board will be entitled to vote on the polls.

As the Scheme is intended primarily to assist in improving the marketing of the factory product, the following classes of producers are exempt from registration under the Scheme and are not entitled to vote on the polls:—

(i) producers who produce the milk products in question on a farm primarily from their own milk and do not use, on the average over a year, more than 1,000 gallons of milk a day in so doing or 300 gallons of milk a day in making cream;

(ii) producers who sell the milk products produced by them solely or mainly by retail and do not use more than 300 gallons a day, on the average over a year, in the production of those products.

Information regarding the Scheme may be obtained from the Secretary, Milk Products Marketing Board, at Room 234, Shell Mex House, Victoria Embankment, London, W.C.2.

Copies of the Scheme* may be obtained either directly from H.M. Stationery Office, York House, Kingsway, W.C.2, or through any bookseller, price 9d. net.

* The Milk Products Marketing Scheme (Approval) Order, 1939, dated August 2, 1939, made by the Minister of Agriculture and Fisheries and the Secretary of State for Scotland under Section 1 (8) of the Agricultural Marketing Act, 1931. (S.R. & O. 1939, No. 905).

MISCELLANEA

National Mark Publicity. A comprehensive range of products, packed and graded to National Mark standards, will be staged by the Ministry at the following Exhibitions :—

The Home Life Exhibition, Leicester ..	September 6-23.
The Dairy Show, Earls Court, London ..	" 26-29.
The Birmingham Grocers' Exhibition ..	" 27-
	October 7.

In addition, there will be Egg Grading Demonstrations at the Leicester and Birmingham Exhibitions, and a Cinema at the Dairy Show. The Ministry's publications will be on sale at each Show.

National Mark "Weeks." Arrangements are being made to hold National Mark "Weeks" at Bath and Oxford during the periods October 11-20 and October 25-November 3 respectively. Preparations for these campaigns are well in hand, and local Advisory Committees have been appointed.

FARM WORKERS' MINIMUM RATES OF WAGES

Enforcement of Minimum Rates of Wages. During the 2 months ending August 12, 1939, legal proceedings were taken against 14 employers for failure to pay the minimum rates of wages fixed by the Orders of the Agricultural Wages Board. Particulars of the cases follow :—

Committee Area	Court	Fines Imposed	Costs Allowed	Arrears of Wages Ordered	No. of workers involved
		£ s. d.	£ s. d.	£ s. d.	
Bucks. ..	Slough ..	5 0 0	6 0	30 0 6	3
Bucks. ..	Slough ..	4 0 0	10 0	111 5 10	4
Essex ..	Ongar ..	6 0 0	3 3 0	28 0 0	3
Glamorgan ..	Gowerton ..	4 0 0	—	59 14 11	2
Lancs. ..	Blackburn	4 0 0	5 0	15 0 0	1
Lancs. ..	Blackburn	*	10 6	7 15 0	1
	Boro'				
Lancs. ..	Darwen ..	*	18 6	48 16 6	1
Lancs. ..	Darwen ..	*	18 6	5 6 2	1
Lancs. ..	Darwen	*	18 6	9 6 6	1
	Boro'				
Lancs. ..	Darwen	*	18 6	35 0 0	1
	Boro'				
Lancs. ..	Standish ..	4 0 0	3 3 0	78 0 0	4
Norfolk ..	Walsingham	1 0 0	8 0	3 15 0	1
Oxford ..	Henley-on-Thames	3 0 0	—	84 0 0	3
Yorks. W.R.	Skipton ..	4 0 0	6 0	61 1 10	1
	Totals ..	35 0 0	12 5 6	577 2 3	27

* Dismissed under the Probation of Offenders Act.

AGRICULTURAL RETURNS OF ENGLAND AND WALES, 1939

ACREAGE UNDER CROPS AND GRASS AND NUMBERS OF LIVE STOCK ON
HOLDINGS ABOVE ONE ACRE IN EXTENT IN ENGLAND AND WALES
AS RETURNED BY OCCUPIERS ON JUNE 3, 1939.

(The figures for 1939 are subject to revision.)

Crops and Grass

Distribution	1939	1938	Increase		Decrease	
	<i>Acres</i>	<i>Acres</i>	<i>Acres</i>	<i>Per cent.</i>	<i>Acres</i>	<i>Per cent.</i>
TOTAL ACREAGE under all CROPS and GRASS	24,628,000	24,711,000	—	—	83,000	0·3
ROUGH GRAZINGS*	5,601,000	5,615,000	—	—	14,000	0·2
ARABLE LAND	8,926,000	8,878,000	48,000	0·5	—	—
PERMANENT GRASS .						
For Hay	4,604,000	4,229,000	375,000	8·9	—	—
Not for Hay	11,098,000	11,604,000	—	—	506,000	4·4
TOTAL	15,702,000	15,833,000	—	—	131,000	0·8
Wheat	1,681,000	1,830,000	—	—	149,000	8·1
Barley	910,000	885,000	25,000	2·8	—	—
Oats	1,357,000	1,301,000	56,000	4·3	—	—
Mixed Corn	83,300	92,900	—	—	9,600	10·3
Rye	16,300	18,500	—	—	2,200	11·9
Beans, for stock feeding or seed	133,000	129,800	3,200	2·5	—	—
Beans, for market or canning	17,700	15,200	2,500	16·4	—	—
Peas, for stock feeding or seed	36,900	38,200	—	—	1,300	3·4
Peas, for canning or packeting, green or dried	27,900	29,000	—	—	1,100	3·8
Green Peas, for market	60,400	57,500	2,900	5·0	—	—
Potatoes, first earlies	56,200	58,500	—	—	2,300	3·9
Potatoes, main crop and second earlies	397,800	416,300	—	—	18,500	4·4
Turnips and Swedes	395,800	423,800	—	—	28,000	6·6
Mangolds	209,800	213,500	—	—	3,700	1·7
Sugar-beet	330,900	328,600	8,300	2·5	—	—
Kohl Rabi	5,400	5,400	—	—	—	—
Rape (or Cole)	53,200	54,400	—	—	1,200	2·2
Cabbage, Savoys and Kale for fodder	88,100	92,700	—	—	4,600	5·0
Cabbage, Savoys, Green Kale and sprouting Broccoli, for human consumption	44,000	43,200	800	1·9	—	—
Brussels Sprouts	37,900	41,300	—	—	3,400	8·2
Cauliflower or Broccoli (non-sprouting)	18,900	19,900	—	—	1,000	5·0
Vetches or Tares	49,100	49,200	—	—	100	0·2
Lucerne	31,700	31,300	400	1·3	—	—
Mustard for seed	23,500	23,700	—	—	200	0·8
Hops	18,900	18,500	400	2·2	—	—
Small Fruit	48,500	49,300	—	—	800	1·6
Orchards	254,000	251,300	2,700	1·1	—	—

* Mountain, Heath, Moor, Down and other rough land used for grazing.

AGRICULTURAL RETURNS

Distribution	1939	1938	Increase		Decrease	
	<i>Acres</i>	<i>Acres</i>	<i>Acres</i>	<i>Per cent.</i>	<i>Acres</i>	<i>Per cent.</i>
CLOVER AND ROTATION GRASSES:						
For Hay	1,304,000	1,186,000	118,000	9·9	—	—
Not for Hay	767,000	715,000	52,000	7·3	—	—
TOTAL	2,071,000	1,901,000	170,000	8·9	—	—
BARE FALLOW	353,800	351,800	2,000	0·6	—	—

The total area used for agriculture in England and Wales on June 3, 1939, according to returns made by occupiers of agricultural holdings exceeding one acre in extent, was 30,229,000 acres, a reduction of 97,000 acres (0·3 per cent.) from the total returned in 1938. The area of rough grazings, including those held in common, declined by 14,000 acres (0·2 per cent.), while the area under crops and grass was reduced by 83,000 acres (0·3 per cent.), compared with a decline of 70,000 acres in 1938. The area of arable land, which had fallen steadily since 1935, recovered to the extent of 48,000 acres, bringing the total to 8,926,000 acres. The fall of 320,000 acres in the area under clover and rotation grasses in 1938 was followed in 1939 by an increase of 170,000 acres (8·9 per cent.) while bare fallow land, which had dropped by 183,000 acres in 1938, showed an increase of 2,000 acres (0·6 per cent.). The total area under permanent grass declined by 131,000 acres (0·8 per cent.); the area for hay was increased by 375,000 acres (8·9 per cent.) but the area not for hay declined by 506,000 acres (4·4 per cent.).

Cereals. There was a sharp decline in the area under wheat, which had risen to 1,830,000 acres in 1938, a reduction of 149,000 acres (8·1 per cent.) being recorded for the current year. The areas under barley and oats, however, showed increases of 25,000 acres (2·8 per cent.) and 56,000 acres (4·3 per cent.) respectively, although the areas under mixed corn and rye showed relatively substantial decreases.

Beans and Peas. The area under beans, which rose noticeably in 1938 was further increased by 5,700 acres, but the increases last year in peas for stock feeding and seed and for canning, etc., were not maintained, decreases of 1,300 acres and 1,100 acres respectively being shown. The area of green peas, however, increased by 2,900 acres (5 per cent.).

Potatoes. The area under potatoes, which showed an increase of 19,500 acres in 1938, declined by 20,800 acres in 1939. First earlies declined by 2,300 acres (3·9 per cent.), and main crop (including second earlies) by 18,500 acres (4·4 per cent.). The acreage returned to the Ministry under potatoes includes all areas of $\frac{1}{4}$ acre and upwards on holdings of over 1 acre in extent and is accordingly larger than the acreage returned to the Potato Marketing Board by registered growers.

Sugar-Beet. Following the increase of 22,000 acres recorded under sugar-beet last year, there was a further increase this year of 8,300 acres (2·5 per cent.).

Roots. The areas of root crops were reduced in 1939; a further fall of 28,000 acres (6·6 per cent.) was recorded for turnips and swedes, while mangolds declined by 3,700 acres (1·7 per cent.).

AGRICULTURAL RETURNS

Vegetable Crops. The acreages of the chief vegetable crops were generally reduced, the exception being cabbage, savoys, green kale and sprouting broccoli for human consumption, where there was an increase of 800 acres (1.9 per cent.). Brussels sprouts declined by 3,400 acres (8.2 per cent.) and cauliflower or broccoli by 1,000 acres (5 per cent.).

Other Crops. Cabbage, savoys and kale for fodder were grown in 1939 on 88,100 acres, a decline on the year of 4,600 acres (5 per cent.). Practically no change occurred in the area under vetches or tares and the lucerne acreage was slightly increased by 400 acres.

Fruit. The area under orchards increased in 1939 by 2,700 acres (1.1 per cent.), resulting in a recovery of part of the loss sustained in 1938 when 7,300 acres went out of cultivation. The area under small fruit declined by a further 800 acres (1.6 per cent.).

Clover and Rotation Grasses and Permanent Grass. The marked decline of 320,000 acres in 1938 in the total area of clover and rotation grass was followed in 1939 by a substantial recovery, the acreage grown for hay rising by 118,000 acres (9.9 per cent.), and the area not for hay by 52,000 acres (7.3 per cent.). The area of permanent grass declined by 131,000 acres; there was an increase in 375,000 acres (8.9 per cent.) for mowing, while the area not intended for hay decreased by 506,000 acres (4.4 per cent.).

Live Stock

Cattle. The total number of cattle increased by 47,900 (0.7 per cent.), the chief increases being recorded in "other cattle" one year old and under two years (4.2 per cent.) and "other cattle" two years and above (5.1 per cent.). There was, however, a decrease of 83,400 (6.1 per cent.) in the cattle of under one year. The dairy herd showed a small net increase of 27,200 after allowing for a slight decline in the number of heifers in calf.

Sheep. There has been a recovery in the total number of sheep each year since 1935 and this tendency was again in evidence in 1939, a net increase of 54,600 being shown. Increases in ewes for breeding (94,500) and in sheep under one year old (263,600) were, however, largely offset by a substantial drop of 303,500 in sheep of one year old and above.

Pigs. While sows for breeding showed an increase of 14,600 (3.4 per cent.), the number of "other pigs" of over two months old fell by 70,700. Pigs under two months old increased by 1,900. For the third successive year, there was a fall in the total pig population, but the recovery in the numbers of sows and young pigs is a hopeful sign for the future.

Horses. The number of horses, on agricultural holdings, which has been declining continuously since 1918, was further reduced in 1939 by 12,000 (1.4 per cent.). All classes were fewer in number on the year with the exception of unbroken horses of one year and above, which increased by 7.0 per cent.

Poultry. The number of fowls showed a slight recovery, the total rising by 199,000 (0.4 per cent.). The increases in old and young birds were 147,000 (0.6 per cent.) and 52,000 (0.2 per cent.) respectively. Ducks, geese and turkeys, however, all showed decreases which amounted to 4.5 per cent., 3.0 per cent. and 11.3 per cent., there being a heavy fall in the numbers of both old and young turkeys, thereby largely wiping out the gain of the previous year.

AGRICULTURAL RETURNS

	1939	1938	Increase		Decrease	
	No.	No.	No.	Per cent.	No.	Per cent.
Cows and Heifers in milk ..	2,251,800	2,236,800	15,000	0·7	—	—
Cows in Calf, but not in milk ..	391,200	375,000	16,200	4·3	—	—
Heifers in Calf	458,500	462,500	—	—	4,000	0·9
Other Cattle :						
Under one year	1,283,000	1,366,400	—	—	83,400	6·1
One year and under two ..	1,344,300	1,290,200	54,100	4·2	—	—
Two years and above ..	1,033,400	983,400	50,000	5·1	—	—
TOTAL OF CATTLE	6,762,200	6,714,300	47,900	0·7	—	—
Ewes kept for Breeding* ..	8,627,400	8,532,900	94,500	1·1	—	—
Other Sheep :						
One year and above	1,225,300	1,528,800	—	—	303,500	19·9
Under one year	8,114,400	7,850,800	263,600	3·4	—	—
TOTAL OF SHEEP	17,967,100	17,912,500	54,600	0·3	—	—
Sows kept for Breeding	448,100	433,500	14,600	3·4	—	—
Other Pigs :						
Over two months	2,175,400	2,246,100	—	—	70,700	3·1
Under two months	886,600	884,700	1,900	0·2	—	—
TOTAL OF PIGS	3,510,100	3,564,300	—	—	54,200	1·5
Horses used for Agricultural purposes (including Mares for Breeding)	548,300	562,200	—	—	13,900	2·5
Unbroken Horses (including Stallions) :						
One year and above	114,800	107,300	7,500	7·0	—	—
Under one year	50,000	52,900	—	—	2,900	5·5
Other Horses	131,600	134,300	—	—	2,700	2·0
TOTAL OF HORSES	844,700	856,700	—	—	12,000	1·4
	No. Thous.	No. Thous.	No. Thous.	Per cent.	No. Thous.	Per cent.
Fowls :						
Over 6 months old	23,092	22,945	147	0·6	—	—
Under 6 months old	29,646	29,594	52	0·2	—	—
TOTAL	52,738	52,539	199	0·4	—	—
Ducks	2,233	2,337	—	—	104	4·5
Geese	591	609	—	—	18	3·0
Turkeys	700	789	—	—	89	11·3

* Including two-tooth ewes.

AGRICULTURAL RETURNS

Agricultural Workers

	1939	1938	Increase		Decrease	
	No	No.	No.	Per cent.	No.	Per cent.
Regular Male Workers :						
21 years old and over ..	374,900	381,700	—	—	6,800	1·8
Under 21 years old ..	95,400	90,200	5,200	5·8	—	—
TOTAL	470,300	471,900	—	—	1,600	0·3
Casual Male Workers :						
21 years old and over ..	57,300	47,900	9,400	19·6	—	—
Under 21 years old ..	5,900	6,300	—	—	400	6·3
TOTAL	63,200	54,200	9,000	16·6	—	—
TOTAL MALE WORKERS, REGULAR AND CASUAL	533,500	526,100	7,400	1·4	—	—
Women and Girls :						
Regular Workers	40,200	41,500	—	—	1,300	3·1
Casual Workers	32,600	25,500	7,100	27·8	—	—
TOTAL	72,800	67,000	5,800	8·7	—	—
TOTAL WORKERS, ALL CLASSES	606,300	593,100	13,200	2·2	—	—

After several years of continuous decreases, the total number of workers showed a gain on the year of 13,200 (2·2 per cent.). The increases occurred in regular male workers under 21 years old (5,200), casual male workers of 21 years and over (9,400) and casual women and girl workers (7,100). Regular adult male workers, however, decreased in number by 6,800, while the decrease in regular women and girl workers was 1,300.

A sub-division of regular male workers under 21 years of age made for the first time this year shows that of the total of 95,400 about 51,000 were under 18 years old.

PRICES OF ARTIFICIAL MANURES

Description	Average prices per ton (2,240 lb.) during week ended August 16.				
	Bristol	Hull	L'pool.	London	Cost per Unit¶
Nitrate of Soda (N. 15½%) ..	£ 8 s.	£ 8 s.	£ 8 s.	£ 8 s.	s d.
" " Granulated (N. 16%) ..	8 5c	8 5c	8 5c	8 5c	10 8
Nitro-Chalk (N. 15½%) ..	8 5c	8 5c	8 5c	8 5c	10 4
Sulphate of Ammonia :—	7 10c	7 10c	7 10c	7 10c	9 9
Neutral (N. 20 6%) ..	7 3c	7 3c	7 3c	7 3c	7 0
Calcium Cyanamide (N. 20 6%) ..	7 11d	7 11d	7 11d	7 11d	7 4
Kainite (Pot. 14%) ..	2 18	2 15	2 15	2 15	3 11
Potash Salts (Pot. 30%) ..	5 0	5 1	5 0	4 17	3 3
" " (Pot. 20%) ..	3 15	3 12	3 12	3 12	3 7
Muriate of Potash (Pot. 50%) ..	8 3	8 8	8 5	8 1	3 3
Sulphate " " (Pot. 48%) ..	9 13	10 0	9 17	9 11	4 0
Basic Slag (P.A. 15½%) ..	2 12b	2 5b	..	2 10b	3 2
" " (P.A. 14%) ..	2 8b	2 0b	2 0b	2 0b	3 3
Grd. Rock Phosphate (P.A. 26-27½%) ..	3 5a	3 0a	2 15a	2 10a	1 10
Superphosphate (S.P.A. 16%) ..	3 6h	..	3 2f	2 19g	3 9
" " (S.P.A. 13½%) ..	..	..	2 19f	2 16g	4 1
Bone Meal (N. 3½%, P.A. 20½%) ..	..	7 5	6 17h	6 12	..
Steamed Bone Flour (N. ½% P.A. 27½—29½%) ..	4 15t	4 15	4 15h	4 12	..

Abbreviations : N. = Nitrogen : P.A. = Phosphoric Acid :
S.P.A. = Soluble Phosphoric Acid : Pot. = Potash.

* Prices are for not less than 6-ton lots at purchaser's nearest railway station unless otherwise stated. Unit values are calculated on carriage-paid prices.

§ Prices are for not less than 2-ton lots, nett cash for prompt delivery, f.o.r., in town named, unless otherwise stated. Unit values are calculated on f.o.r. prices.

a Prices for 4-ton lots f.o.r. Fineness 85% through standard sieve.

b Prices for 6-ton lots. Prices at Bristol are f.o.r. Bridgwater; at Hull and Liverpool f.o.r. neighbouring works and at London f.o.r. at depots in London districts. Fineness 80% through standard sieve.

c For lots of 4 tons and under 6 tons the price is 1s. per ton extra, for lots of 2 tons and under 4 tons, 5s. per ton extra, for lots of 1 ton and under 2 tons, 10s. extra, and for lots of 2 cwt. and under 1 ton, 20s. extra.

d Delivered in 5-ton lots at purchaser's nearest railway station. For lots of 2 tons and under 5 tons the price is 5s. per ton extra, for lots of 1 ton and under 2 tons, 10s. per ton extra, and for lots of 4 cwt. and under 1 ton, 20s. extra.

f Prices shown are f.o.r. Widnes.

g Prices shown are ex works London; for southern rails, 1s. 3d. extra.

h Prices shown are f.o.r. Appley Bridge.

i Price shown is f.o.r. Newport, Mon.

h Price shown is f.o.r. Avonmouth.

¶ These are calculated by regarding a ton as comprising 100 "units" (equal parts of 22.4 lb.) so that a fertilizer, for example, with 16 per cent. nitrogen contains 16 such "units" in a ton. Then, if the price per ton of such a fertilizer be divided by the percentage figure, the deduced cost is that of a "unit" of that agent. Those in the table above are based on London prices. (For further explanation, see Advisory Leaflet, No. 146, "The Valuation of Artificial Manures," obtainable from the Ministry free of charge.)

PRICES OF FEEDING STUFFS

Description	Price per ton	Manu- rial value per ton	Cost of food value per ton	Starch equiv. per 100 lb	Price per unit starch equiv	Price per lb. starch equiv	Pro- tein equiv.
Wheat, British ..	£ s. 4 18†	£ s. 0 9	£ s. 4 9	72	s. d. 1 3	d. 0·67	% 9·6
Barley, Canadian—							
No. 3 Western	5 10	0 9	5 1	71	1 5	0·76	6·2
Australian ..	5 15§	0 9	5 6	71	1 6	0·80	6·2
Iranian ..	5 2*	0 9	4 13	71	1 4	0·71	6·2
Moroccan ..	5 2§	0 9	4 13	71	1 4	0·71	6·2
Russian ..	5 10	0 9	5 1	71	1 5	0·76	6·2
Oats, English white ..	6 7	0 9	5 18	60	2 0	1·07	7·6
" " black and grey ..	6 7	0 9	5 18	60	2 0	1·07	7·6
Scotch, white ..	6 10	0 9	6 1	60	2 0	1·07	7·6
Canadian—							
No. 2 Western	6 8	0 9	5 19	60	2 0	1·07	7·6
No. 1 feed	6 5	0 9	5 16	60	1 11	1·03	7·6
Mixed feed ..	5 3	0 9	4 14	60	1 7	0·85	7·6
Maize, American ..	5 8†	0 7	5 1	78	1 4	0·71	7·6
Argentine ..	5 8	0 7	5 1	78	1 4	0·71	7·6
Danubian Gal.							
Fox ..	5 8†	0 7	5 1	78	1 4	0·71	7·6
Peas, Russian ..	6 12†	0 15	5 17	69	1 8	0·89	18·1
Japanese ..	20 15†	0 15	20 0	69	5 10	3·12	18·1
Dari, Egyptian ..	8 0†	0 8	7 12	74	2 1	1·12	7·2
Milling Offals—							
Bran, British ..	4 17	0 17	4 0	43	1 10	0·98	9·9
" Imported ..	4 17	0 17	4 0	43	1 10	0·98	9·9
" Broad ..	4 17	0 17	4 0	43	1 10	0·98	10·0
Middlings, fine, im- ported ..	5 10	0 14	4 16	69	1 5	0·76	12·1
Weatings† ..	5 7	0 15	4 12	56	1 8	0·89	10·7
" Superfine†	5 15	0 14	5 1	69	1 6	0·80	12·1
Pollards, imported ..	5 0	0 15	4 5	50	1 8	0·89	11·0
Meal, barley ..	6 15	0 9	6 6	71	1 9	0·94	6·2
" grade II ..	6 0	0 9	5 11	71	1 7	0·85	6·2
" maize ..	6 0	0 7	5 13	78	1 5	0·76	7·6
" " South African	5 7	0 7	5 0	78	1 3	0·67	7·6
" " germ ..	6 2	0 11	5 11	84	1 4	0·71	10·3
" locust bean ..	7 5	0 6	6 19	71	1 11	1·03	3·6
" bean ..	8 10	0 18	7 12	66	2 4	1·25	19·7
" white fish ..	16 2	2 6	13 16	59	4 8	2·50	53·0
" Soya bean (extracted)† ..	9 15	1 11	8 4	64	2 7	1·38	38·3
Maize, cooked, flaked	6 7	0 7	6 0	84	1 5	0·76	9·2
" gluten feed	6 10	0 14	5 16	76	1 6	0·80	19·2
Linseed cake—							
English, 12% oil ..	9 10	1 1	8 9	74	2 3	1·21	24·6
" 9% " ..	8 17	1 1	7 16	74	2 1	1·12	24·6
" 8% " ..	8 12	1 1	7 11	74	2 0	1·07	24·6
American, 5½% ..	8 15†	1 1	7 14	74	2 1	1·12	24·6

PRICES OF FEEDING STUFFS—(continued)

Description	Price per ton	Manu- rial value per ton	Cost of food value per ton	Starch equiv. per 100 lb.	Price per unit starch equiv.	Price per lb. starch equiv.	Pro- tein equiv.
	£ s.	£ s.	£ s.		s. d.	d.	%
Linseed Cake—							
Indian, 9% oil ..	8 10†	1 1	7 9	74	2 0	1·07	24·6
Cottonseed cake,							
English, Egyptian							
seed, 4½% oil ..	5 5	0 19	4 6	42	2 1	1·12	17·3
Cottonseed cake,							
Egyptian, 4½% oil ..	5 0	0 19	4 1	42	1 11	1·03	17·3
Cottonseed cake,							
decorticated, 7-8% oil	7 15†	1 10	6 5	68	1 10	0·98	34·7
Cottonseed meal,							
decorticated, 7-8% oil	7 15†	1 10	6 5	70	1 9	0·94	36·8
Coconut cake, 5-6% oil	7 0	0 19	6 1	77	1 7	0·85	16·4
Ground nut cake,							
6% oil ..	6 5*	1 0	5 5	57	1 10	0·98	27·3
Ground nut cake,							
decorticated, 6-7% oil	8 10*	1 10	7 0	73	1 11	1·03	41·3
Ground nut cake,							
imported decorticated,							
6-7% oil ..	7 0	1 10	5 10	73	1 6	0·80	41·3
Palm-kernel cake,							
4½-5½% oil ..	6 10†	0 13	5 17	73	1 7	0·85	16·9
Palm-kernel cake meal,							
5½% oil ..	6 12†	0 13	5 19	73	1 8	0·89	16·9
Palm-kernel meal,							
1-2% oil ..	6 5	0 13	5 12	71	1 7	0·85	16·5
Feeding treacle ..	4 15†	0 8	4 7	51	1 8	0·89	2·7
Brewers' grains, dried ale	5 0	0 12	4 8	48	1 10	0·98	12·5
Brewers' grains, dried porter ..	4 12	0 12	4 0	48	1 8	0·89	12·5

* At Bristol.

§ At Hull.

† At Liverpool.

‡ In these instances manurial value, starch equivalent and protein equivalent are provisional.

NOTE: The prices quoted above represent the average prices at which actual wholesale transactions have taken place in London, unless otherwise stated, and refer to the price ex mill or store. The prices were current at the beginning of August, 1939, and are, as a rule, considerably lower than the prices at local country markets, the difference being due to carriage and dealers' commission. Buyers can, however, easily compare the relative values of the feeding stuffs on offer at their local market by the method of calculation used in these notes. Thus, if linseed cake is offered locally at £11 per ton, then since its manurial value is £1 1s. per ton as shown above, the cost of food value per ton is £9 19s. Dividing this figure by 74, the starch equivalent of linseed cake as given in the table, the cost per unit of starch equivalent is 2s. 8d. Dividing this again by 22·4, the number of pounds of starch equivalent in one unit, the cost per lb. of starch equivalent is 1·43d. Similar calculations will show the relative cost per lb. of starch equivalent of other feeding stuffs on the same local market. From the results of such calculations a buyer can determine which feeding stuff gives him the best value at the prices quoted on his own markets. The figures given in the table under the heading "manurial value per ton" are calculated on the basis of the following unit prices:—N, 7s. 9d.; P₂O₅, 2s. 6d.; K₂O, 3s. 6d.

FARM VALUES OF FEEDING STUFFS

The prices in respect of the feeding stuffs used as bases of comparison for the purpose of this month's calculations are as follow :—

	<i>Starch equivalent Per cent.</i>	<i>Protein equivalent Per cent.</i>	<i>Per ton £ s.</i>
Barley (imported)	71	6·2	5 8
Maize	78	7·6	5 8
Decorticated ground-nut cake ..	73	41·3	7 15
„ cotton-seed cake ..	68	34·7	7 15

(Add 10s. per ton, in each instance, for carriage.)

The Table below is issued as a guide to farmers respecting the feeding value of their crops in relation to current market prices. (The "food values," which it is recommended should be applied by Agricultural Organizers and other advisers in connexion with advisory schemes on the rationing of dairy cows, are given in the December, 1938, issue of the Ministry's JOURNAL, p.965.)

FARM VALUES

Crop	Starch equivalent Per cent.	Protein equivalent Per cent.	Food value per ton, on farm £ s.
Wheat	72	9·6	5 19
Oats	60	7·6	4 19
Barley	71	6·2	5 12
Potatoes	18	0·8	1 7
Swedes	7	0·7	0 11
Mangolds	7	0·4	0 11
Beans	66	19·7	6 8
Good meadow hay	37	4·6	3 1
Good oat straw	20	0·9	1 10
Good clover hay	38	7·0	3 6
Vetch and oat silage ..	13	1·6	1 1
Barley straw	23	0·7	1 14
Wheat straw	13	0·1	0 19
Bean straw	23	1·7	1 16

Control of Potato Slugs

In an article on this subject in the August issue (pp. 454-462) it was stated that, in the opinion of the author, "meta" appeared to be non-poisonous to human beings, domestic animals and birds. It has been brought to our notice, however, that this material is sold with the warning "acts as poison," and that it should therefore be dealt with judiciously.

AGRICULTURAL INDEX NUMBER

MONTHLY INDEX NUMBERS OF PRICES OF AGRICULTURAL PRODUCE
(BASE, 1927-29=100.)

Uncorrected for
Seasonal Variation

*Corrected for
Seasonal Variation*

Month	1937	1938	1939	1937	1938	1939
January	90	97	90	85	90	84
February	91	95	88	86	89	82
March	90	88	85	90	88	85
April	89	85	85	92	89	89
May	81	82	77	88	90	86
June	83	81	75	89	90	83
July	82	86	80	88	94	87
August	83	81		87	86	
September	87	81		89	83	
October	93	86		89	82	
November	99	89		92	82	
December	100	90		92	82	

THE SAME, TAKING ACCOUNT OF PAYMENTS UNDER THE WHEAT ACT (a),
THE CATTLE SUBSIDY (b), AND GOVERNMENT PAYMENTS FOR MILK (c).

Month	1937	1938	1939	1937	1938	1939
January	92	99	95	86	93	89
February	93	97	93	88	92	88
March	92	91	90	92	91	90
April	90	88	90	93	92	94
May	83	84	82	90	92	91
June	82	83	80	89	92	88
July	83	88	85	89	96	93
August	85	84		89	89	
September	89	84		91	86	
October	95	91		91	86	
November	101	94		94	86	
December	102	94		94	86	

(a) Commenced August, 1932. (b) Commenced September, 1934.
(c) Commenced April, 1934.

RECENT OFFICIAL PUBLICATIONS

The Manufacture of Charcoal in Portable Kilns. (Department of Scientific and Industrial Research. Forest Products Research Records—No. 29.) Charcoal burning as practised from time immemorial is a highly skilled craft if not an art, and the race of skilled burners is almost extinct in England. Portable metal kilns have been introduced to enable ordinary labour to produce usable charcoal, but disappointment has often been experienced with this apparatus, as frequently the essential conditions for a successful burn were not known. The Forest Products Research Laboratory has investigated the conditions of burning, and this report should prove of interest to owners of woodland areas and others concerned with the possibilities of charcoal manufacture as a means of disposal of wood which would otherwise be useless. Price 6d., by post 7d.

WIRELESS TALKS, SEPTEMBER, 1939

<i>Station and Date</i>	<i>Time p.m</i>	<i>Speaker</i>	<i>Subject</i>
MIDLAND : 14	6 45	Probably Professor Scott Watson, Syd Carter and one other	Farm Diary . First of a new series
WEST : 1	8 10	—	The Wanderer.
WEST . 4	9 50	—	The Cyder Land
REGIONAL 5	4 00	—	The Cyder Land
WEST AND REGIONAL 6	6 40		Hand and Machine
REGIONAL . 8	12 15	—	Hand and Machine
WEST 7	9 15	Anthony Hurd	For Western Farmers in Particular
10	5 25	A G. Street	How to Look at the Countryside
REGIONAL 14	1 00	A G. Street	How to Look at the Countryside
NORTH . 14	9 30	—	It is hoped to give an eye-witness account of the Westmorland Agricultural Show

NOTICES OF BOOKS

Calcium Superphosphate and Compound Fertilizers : Their Chemistry and Manufacture. By P. Parrish and A. Ogilvie Pp. xiv + 322
 Illus (London Hutchinson 1939. Price 35s)

This book is mainly for works chemists and gives an admirable and unbiased account of the advantages and disadvantages of the many types of plant which are being used for the manufacture of phosphatic fertilizers. Although primarily a discussion of production technique, it cannot fail to arouse interest in the minds of agriculturists, since it examines the reasons for the treatment of the raw phosphate rock and gives an account of the varying availability and physical condition of the resulting fertilizers. It treats at length the possible trends of production in the future. After consideration of this latter point, agricultural chemists and advisers will no doubt be prompted to enquire whether these trends, which the manufacturers are following in response to popular demand, are desirable and whether production on these lines can be scientifically justified. The increasing use of granular fertilizers is an example of this, and readers will agree with the authors when they say "Many aspects surround the question of the efficiency of the application of fertilizers and it is obviously a subject which should be investigated in the interests alike of the farmers and the fertilizer manufacturers."

A further chapter which will be of interest to all those concerned in agriculture is that dealing with compound fertilizers and the chemical reactions obtaining when fertilizers are mixed. This section is particularly informative and one would wish that space could have been found for a substantial extension of the chapter.

The admirable illustrations are deserving of special praise; it is rare that the working of machinery is so clearly demonstrated by sectional views.

NOTICES OF BOOKS

International Directory of Agricultural Libraries. Pp. 311. (Rome: I.A.I. 1939. Price 25 Lire.)

This reference book, based chiefly on the results of a questionnaire sent to a great number of libraries, has just been published and should be of considerable use to scholars and research workers interested in agricultural subjects. Details are given in two languages—English and French—of about 1,200 agricultural libraries, and the information is summarized under the following headings:—

(i) The history of the library; (ii) Collection (subjects represented in the library; size of the whole collection; the special collections); (iii) Library administration (cataloguing and classification systems; staff, etc.); (iv) Use of the library (hours of opening, reading and reference rooms, external loans; annual average of readers and circulation); (v) Relations with other libraries (inter-library exchanges of publications and of duplicates; inter-library loans within the country and with foreign countries); (vi) Publications edited by the library; (vii) Bibliography of writings on the library.

The questionnaire was addressed to: (a) General agricultural libraries of over 2,000 volumes; (b) Agricultural libraries specialized in particular subjects; (c) Agricultural collections in general libraries (limited mainly to university libraries); and (d) Centres of agricultural documentation.

Protein Metabolism in the Plant. By A. C. Chibnall. Pp. xiii + 306. Illus. (U.S.A., New Haven: Yale University Press, and London: Oxford University Press 1939. Price 18s.)

Professor Chibnall's monograph adds another volume to the distinguished list of books based on Silliman Memorial Lectures. It is essentially a book for advanced university students and research workers, but it is so clearly written that it can be followed by readers having quite an elementary knowledge of organic chemistry. Following a masterly discussion of protein metabolism in seedlings, is the most valuable part of the book—that dealing with protein metabolism in leaves. Fifteen years ago, practically nothing was known of the chemistry of leaf proteins, and the knowledge since acquired is presented here for the first time. Research work published in over 300 separate papers, including the important work of Professor Chibnall himself, is critically examined, both as regards laboratory technique and the interpretation of results. The importance of technique is well illustrated in the chapter on the proteins of pasture plants, for it is still difficult to correlate results of feeding experiments with those of pure chemistry. Finally, evidence for a protein cycle in leaves is critically considered. The author emphasizes that, as leaf proteins are part of the protoplasm itself, it is essential to find out more about the conditions under which proteins exist in living cells. His aim is to stimulate future research in that direction, and the book should certainly succeed in doing this.

Sagas of the Evergreens. By F. H. Lamb. Pp. 364. Illus. (London: John Lane. 1939. Price 16s.)

In this book we meet all the evergreen trees that so wonderfully contribute to the well-being of the world. We meet many of them as real sentient beings, like "Grandfather Grinkgo" and "Miss Taxifolia," and though many of them are truly feminine, English readers will find it difficult to read of trees several thousands of years old yet still in their prime, and of annual growths of several inches in diameter and many feet in height.

The author maintains throughout full appreciation of the beauty of the living tree, but he also sees the beauty of many of the products. Technical

NOTICES OF BOOKS

descriptions of processes of growth, "falling," logging and all the many skilled sides of a lumberman's life are very readable.

The chapter on "Cinderella" (W. Hemlock) is especially attractive, and is perhaps the best of the many descriptions that point to the full romance of lumber, which will provide man with his beautiful woodwork, his ethyl, his cellophane and clothing, and will even assist in making his dynamite and his car battery.

Due warning is given of the need for replanting, general management and fire-fighting, but these might well have been further emphasized and more importance given to the necessity for national efforts in these directions.

Principles of Genetics. By E. W. Sinnott and L. C. Dunn. 3rd Edition Pp. xiv + 408. Illus. (London: McGraw-Hill Publishing Co., Ltd. 1939. Price 21s)

The third edition of Sinnott and Dunn's well-known book gives the same clear and detailed exposition of the principles of genetics as is familiar from the earlier editions. A considerable amount of new material and many new illustrations have been added, rendered necessary by the rapid progress made in the last six years. Considerable re-writing of portions of the book has also been undertaken. Some of the main subjects on which additional matter has been included are the use of radiation in the study of mutation, the mechanism of crossing over, cytoplasmic inheritance, heterosis, mutation frequency in natural populations, and statistical methods for the study of populations. The linear arrangement of genes in the chromosomes is fully discussed, and Bridges's maps of the chromosomes of the salivary gland cells of *Drosophila* are included in a folding frontispiece. A number of new problems have also been added, as "aids for thought and discussion." The book may be regarded as a standard text in the well-known McGraw-Hill series.

The Englishman's Food. Five Centuries of English Diet. By J. C. Drummond and Anne Wilbraham. Pp. 574 Illus (London Jonathan Cape. 1930. Price 12s. 6d)

Food, if only by its diurnal recurrence, is one of the most important elements in life; but it is only of recent years that diet and health have been effectively correlated. Even now there is much still to learn on this most important subject. By so much the more welcome is this exhaustive study of the changes in diet that have become possible as a result of the improvements in agricultural technique, transport and processing during the past five centuries.

The authors describe the limitations of diet imposed upon our forefathers by reason of their elementary methods of farming and the resulting deficiencies in diet and their effects upon all classes of society. Several diseases that were endemic five centuries ago were directly caused by these deficiencies, but have now practically, if not entirely, disappeared as a result of a more productive system of farming, combined, of course, with more scientific methods of food processing, storage and transport. The story is a fascinating one, and, although the scientific analyses provided will often be rather difficult for a layman, they have been presented in as simple a manner as is compatible with accurate statement, and the authors have exploded many of our most popular food fallacies and fads.

The well-chosen illustrations lend light relief to the subject and some of them, at least, form an amusing commentary upon the table manners of our well-to-do classes in a not too distant past.

NOTICES OF BOOKS

Agriculture in the Twentieth Century. A Collection of Essays. Pp. viii + 400. (Oxford: The Clarendon Press. 1939. Price 15s.)

Following the custom which is now becoming fashionable for celebrating distinguished scientific and literary men on their retirement, a number of Sir Daniel Hall's friends have collaborated in presenting to him a volume of essays descriptive of the work which has been accomplished in the fields of agricultural research and education during, roughly, the last fifty years.

Sir John Russell writes on the development of soil science; Dr. C. Crowther on animal nutrition; Mr. Orwin on farming as a business; Dr. R. G. Hatton on scientific fruit growing. Other contributors include Dr. R. M. Salaman, Mr. J. Mackintosh, Dr. J. A. Venn, Professor A. W. Ashby, Sir J. B. Orr, Dr. H. Hunter, Mr. J. C. F. Fryer and Mr. H. E. Dale.

A book from such a distinguished company of authors naturally raises great expectations, and although the subject matter of these essays contains little that has not been said before, the opportunity was here to put into perspective the many scattered pieces, and to view as a whole the development of agricultural research and educational work, in connexion with which Sir Daniel has himself played no small part. Brilliant as are some of these essays, however, there is a feeling of disjointedness about the book which may have resulted from the fact that the disadvantages of a joint authorship have not been countered by a very happy arrangement of chapters. Sir Daniel Hall is primarily a man of science, and it might, therefore, have been more appropriate, and certainly more interesting, to have dealt first with the scientific development of agriculture and to have reserved the discussion of policy and administrative machinery for later consideration in the volume.

The Civil Service is treated to an unusual degree of prominence by becoming the subject of the first essay in the book; but as the book contains essays dealing with the broader questions of agricultural policy, it may be doubted whether another essay on administrative machinery and one largely concerned with personalia was really called for.

Seed and Potting Composts. By W. J. C. Lawrence and J. Newell. Foreword by Sir Daniel Hall. Pp. 128. Illus. (London: Allen & Unwin, Ltd. 1939. Price 3s. 6d.)

While conducting plant-breeding experiments, the authors encountered many failures in germination and growth of seedlings, which they traced to the usual methods of preparing composts. Experiments were undertaken, therefore, to devise composts for seeds and for potting which would conform to the following conditions. It should be in good physical condition; it should provide adequate and balanced food supply for the plant at every stage of its growth; it should be free from harmful organisms and substances.

This little book describes in simple language the composition of the composts which they found most successful. The theoretical aspects are necessarily dealt with in a rather elementary manner, since the book is written for private and commercial gardeners, yet the recommendations are described in a thoroughly practical and very detailed manner.

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THE JOURNAL OF THE MINISTRY OF LIBRARY AGRICULTURE

VOL. XLVI

No. 7

DECEMBER 1939

Up Corn, Up Horn

During the war of 1914-18, when the need for increased home food production had become apparent, Lord Ernle, then President of the Board of Agriculture, concluded a letter to Agricultural Executive Committees with the words "For the Nation's sake let us take as our motto 'Back to the 'seventies and better.' We cannot do more. I am sure that farmers will not do less."

That this policy had a great measure of success we all know. In 1916, when the food-production campaign really started, we had 11,051,000 acres of arable land. By 1918 this had been increased to 12,399,000 acres. With the return of peace, however, farmers reverted to grassing down and the arable acreage shrunk again, the fall between 1918 and 1938 being 3,500,000 acres. Simultaneously our population (England and Wales) increased from 36 million in 1918 to 41 million in 1937.

Although our dependence on imported foodstuffs is greater than in the last war, not to speak of the 'seventies, we have certain factors in our favour as compared with 1916. At the outbreak of the present war a good start had already been made in breaking up or improving poor grass land, the land fertility campaign was in full swing, and the tractors and other machinery available, and since substantially increased, ensure that the necessary cultivations can be effected much more speedily, even if no better, than in 1916.

Even so, there is much leeway to make up. In the 'seventies, with a population of 23 million, we had 14½ million acres of arable land. Now we have only 8,926,000 acres.

It is essential, therefore, that all connected with the land should put their best foot foremost—the farm labourer, the farmer, the landowner—and even the townsman or suburban dweller with his allotment or vegetable garden. We must

plough and dig for victory. We have valuable assets in our live stock whose numbers are much greater than in the last war. If they are to be maintained, however, they must return to the ways of their ancestry and become fruitful and multiply on the natural products of their native land. It must be neither "Up Corn and down Horn," nor "Up Horn and down Corn," but "Up Corn and Up Horn." For half a century or more it has suited the national interest that farmers should concentrate on increasing the output of milk, pigs and eggs, and in doing so make increasing use of imported feeding stuffs. Now farmers have to switch over as quickly as they can to the cultivation not only of more crops for human consumption but also of more foodstuffs for their animals. To-day corn and horn are complementary, as indeed they must always be, if the country is fully to develop its natural resources and "the artists who feed the world" are to reap the just reward of their labours.

The "Journal"

It has been decided that during the war the JOURNAL of the Ministry shall be published at three-monthly intervals in place of the monthly issue in peace time. This change has been deemed advisable not only in the interest of economy of materials, but because the problems of immediate urgency to farmers, such as inevitably arise in the course of an intensive food-production campaign, can be dealt with more appropriately by means of broadcasting, or through the daily or weekly Press, than through the medium of a monthly publication. There are still, however, many subjects of war-time agricultural interest which can be studied in the more leisurely atmosphere of a quarterly journal, and the Minister trusts that his decision to continue the issue of the JOURNAL on that basis will be welcomed by many who are concerned with practical or scientific agriculture.

PIG KEEPING IN WAR TIME

I. GENERAL

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In 1914, the pig population of the United Kingdom was 3.95 millions. By 1918, the number had fallen to 2.81 millions. In June, 1939, the corresponding figure was 4.39 millions. After 1918, development had been mainly in the direction of specialized pig farms, or specialized pig units on mixed holdings, but either way, pigs were fed almost wholly upon concentrated food—much of it imported from abroad. And we have to face the possibility that, in war, transport difficulties may interfere with importations from overseas. Moreover, in emergency, certain concentrated foods normally used for pig feeding, may be required for human consumption. As Sir Thomas Middleton has said, "It is better to keep five men alive on barley meal, than one comfortably nourished on pork."

It seems, therefore, that it would help materially to maintain the existing pig population of the country, if pigs could be distributed over as many farms and back yards as possible. The cottager's pig needs to be revived. In this way, they could be fed more fully on farm produce, like damaged corn, or "seconds" from the threshing machine, household scraps, potatoes, "roots," green crops, grass, vegetables, etc.

At one time, pigs were kept on almost every farm, and by very many householders and cottagers throughout the countryside. In those days, the pigs were fed chiefly on skim milk, sharps, barley meal, scraps and green stuff, and those foods, collectively, formed a perfectly sound, balanced ration. Nowadays, however, skim milk is not available, except in exceptional circumstances, and so a vital part of the good old-fashioned ration has disappeared. In peace time we have replaced the skim milk with white-fish meal, or whale-meat meal, or meat and bone meal, or one or other of the various foods which supply animal protein and minerals, but these

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foods are now difficult to obtain. The usual substitutes are the protein-rich vegetable foods, such as soya-bean meal, or decorticated ground-nut cake, used in conjunction with feeding bone meal or a mineral mixture. But the soya-bean and ground-nut products have not been easy to come by. Actually, up to date, it has been easier to get fish meal and linseed-cake meal, and at the Moulton Institute Farm we have been using 5 per cent. of each of these foods, in place of the usual 10 per cent. of white-fish meal in the rations of breeding stock. It is necessary, however, in existing circumstances, to be prepared at any time to change the ingredients of a ration, and to make use of whatever may be available from time to time. Farmers who have home-grown beans have an advantage in so far as the beans form a useful source of protein, and those who may be favourably placed to get butcher's slaughter-house by-products, will find that the latter, *well boiled*, help materially to fill the gap.

It is now pretty widely recognized that 4 lb. potatoes (preferably cooked), or 8-10 lb. mangolds, swedes, kale or grass, will replace 1 lb. of barley meal or maize meal in food value. Some years ago on the Institute Farm, we fed in-pig sows out of doors, in winter, on 2 lb. meal and all the raw potatoes which they cared to eat. We found that on the average, they ate round about 16 lb. of potatoes daily. Their meal ration consisted of $\frac{1}{2}$ lb. white-fish meal and $1\frac{1}{2}$ lb. sharps (weatings). We had reckoned that if the sows had each been receiving 5 lb. meal daily, without potatoes, and this meal had contained the usual 10 per cent. of white-fish meal, the daily allowance of fish meal per head would have been $\frac{1}{2}$ lb. So we gave them $\frac{1}{2}$ lb. fish meal daily, mixed into $1\frac{1}{2}$ lb. sharps and the potatoes. They thrived very well, although they were continuously rather loose in the dung, but they subsequently farrowed all right, and reared their litters quite satisfactorily. This seems to have been what would now be called a sort of Lehmann feeding system, although we had not, at that stage, heard of either Lehmann or his system.

In the feeding of bacon pigs, the war-time practice which we have adopted is to limit the use of meal, and to supplement it with roots or green food—so far, kale and kohlrabi. The pig, after weaning, gets 2 lb. meal daily, and just as much greenstuff as it will clear up. The meal is slowly and gradually increased, but at no stage exceeds 4 lb. daily, while all the time the pig's appetite is satisfied with just as much

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green food as it cares to eat, in addition to the meal. In this way, the daily meal consumption is restricted to about two-thirds of that usually employed under peace-time conditions. That being so, and as the green fodder is relatively low in protein, the meal ration should, preferably, contain 15 per cent. of high protein food, instead of the usual 10 per cent. And if feeders can get the necessary protein-rich foods, it is certainly advisable to raise the percentage to the figure stated, so that on the reduced daily intake of meal, the pig will still get as much protein as was customary when fed on peace-time rations. In brief, that is more or less, the Lehmann system.

It has become a widespread practice to give some cod-liver oil to pigs in winter. The cod-liver oil supplements the vitamin supply, and helps to protect the pig from colds, chills, and lung affections. Cod-liver oil is still obtainable, but has gone up substantially in price. It is therefore all the more important that it should be used with economy. Half an ounce per pig per day, prior to weaning, increased to 1 oz. daily, for a month or six weeks after weaning, should serve the purpose.

Generally, food consumption in relation to live-weight gain, can be maintained within the most favourable limits, in winter, if pigs are kept dry, warm and comfortable, and have plenty of trough room. Where pigs are kept in cold, damp, draughty, miserable conditions, and have to fight and struggle to get a place at the trough, it is amazing how much of the food is needed to keep up the body temperature, and to provide for expenditure of energy, and how little is available to put on live-weight gain. *Warm* food in very cold weather is an advantage, and another important point is that excess of water in the food does harm by diluting the digestive juices, and by chilling the body. It is far better to give the food just damp, and to provide extra drinking water in a trough, than to compel a pig to drink much water in proportion to the dry matter in the food. Moreover, excess of water results in excessive urination, so increasing dampness, fouling of the litter, and the general discomfort of the sty.

It has been suggested that, under existing conditions, sows of the breeds which can make most use of roughage should be favoured. In theory, this is excellent, but the question arises which are those breeds? It would appear that it is more a matter of strain, than breed. There are vigorous,

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thrifty sorts in most herds, which have been maintained for a period of years under outdoor conditions, and particularly where care has been devoted to selection for thriftiness and strong constitution, and where indiscriminate in-breeding and close line-breeding have been avoided.

Heavy milk yield on the part of the sow is more than ever of absolutely fundamental importance, because if young pigs get a good start in life on their mother's milk, they are far better prepared to withstand the ill effects of shrunken and variable meal rations, and of reduced provision of animal protein—and still keep their tails curled!

II. EXPERIMENTS WITH GREEN FORAGE

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It is essential in war time that pigs should be kept as far as possible upon the produce of the farm, also that the use of meal should be reduced to a minimum. Experiments have been carried out at this Station during the past two years, designed to obtain information regarding the feeding value of green forage and the best method of utilizing foods of this type. The results show that, on the lines indicated below, it is possible by the use of green crops to effect a saving of 20 per cent. of the meal consumed by sows, strong stores and fattening pigs, *without any loss of efficiency*.

All the green forage crops are comparatively bulky, and it takes 6-7 lb. of green material to replace 1 lb. of meal. A pig can eat the comparatively large quantity of green material which is required to replace any appreciable quantity of meal only when *the green crop is young*. When green leaves get old and fibrous, pigs cannot eat a very large quantity. This also applies to grass, which must be kept well grazed to enable pigs to utilize it to the best advantage.

All the green crops have a comparatively high fibre content and are best used to replace millers' offals in pig rations. If, owing to the state of supplies, it should be desirable to increase the proportion of millers' offals in the rations given below, a *slight* loss of efficiency must be expected.

The fact that the rations suggested below are efficient is

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shown by results obtained with similar rations in experiments which are at present in progress at this Station, as follows:—

(1) WITH NURSING SOWS

	No. of Litters	No. of Pigs Total	Per Litter	Average Weaning Weight per Pig
Controls (Standard Ration)	6	51	8.5	32.1 lb.
Rations containing green forage	6	51	8.5	33.6 „

Four of the litters from the green forage group weighed over 300 lb. at weaning, as did 3 of those in the Control group.

(2) WITH FATTENING PIGS (60-120 lb.) LIVE WEIGHT :

	No. of Pigs	Consumed Meal per 1 lb. Increase
Control group (on Standard Ration)	3 lots of 5 = 15 pigs	3.5 lb.
Green forage group	3 „ „ 5 = 15 „	2.9 „

RATIONS FOR IN-PIG AND NURSING SOWS

8½ parts by weight	Cereal Meals.	(a)
5 „ „ „	Weatings (sharps or middlings).	(b)
2½ „ „ „	Protein feed.	(c)

In-pig Sows :

2-3 lb. per head per day, *plus green food ad. lib.*

Nursing Sows :

¾ lb. per pig per day (e.g., a sow suckling 8 pigs to receive 6 lb. meal), *plus green food ad. lib.*

(a) In the Wye Trials, the cereal meal used was barley meal, but maize meal, flaked maize, wheat meal or tapioca meal may be substituted for part of the barley meal without reducing the efficiency of the ration.

(b) If millers' offals are not available, their place may be taken by finely ground oats, or if neither is available, 16 parts of cereal meals may be used. If cereal meals are short and millers' offals available, the proportion of the latter may be increased.

(c) *Protein Feed.* In the Wye Trials, 2 parts by weight of white-fish meal and ½ part soya-bean meal was used. Such evidence as exists indicates that if a minimum of 1 part of white-fish meal, whale-meat meal, or meat meal be used, the balance (1½ parts) may be replaced by an equivalent quantity of any protein feed available, such as soya-bean meal, decorticated ground-nut cake, palm-kernel cake, bean meal, pea meal, etc., but, if they are used, 1½ lb. ground limestone or chalk, and ½ lb. salt should be added per 1 cwt. mixed meal.

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Rations for Young Pigs. There is no economy in under-nourishing young pigs up to the time they are about 50 lb. live weight, as such a practice invariably results in weakly, anaemic pigs, that grow slowly and are difficult to rear.

Sucking Pigs. These should be encouraged to eat at the earliest possible age. They may be started on either of the following rations:

3½ parts barley meal, 1½ parts flaked maize, 5 parts weatings.
or 1 part barley meal, 1 part weatings.

To both of these rations, 1½ lb. ground limestone or chalk, and ½ lb. salt should be added per cwt. of mixed meal, and green food given *ad lib*.

As soon as the piglings are eating an appreciable quantity of the above (i.e., between the ages of 5 and 6 weeks), the ration should be changed to a mixture containing a protein feed, such as:

9 parts barley meal, 9 parts weatings, 2 parts white-fish meal.
or 6 " " " 3 " finely ground oats, 2 parts white-fish meal.

The piglings should receive all the meal they will clear up readily twice a day, plus green food *ad lib*.

This method of feeding should be continued until the pigs are about 60 lb. live weight, when they should be eating about 3 lb. of meal.

At this stage, they may be changed on to the following:

5½ parts by weight cereal meals. (d)
1 " " " " protein food. (e)

using two-thirds the usual quantity of meal and allowing green food *ad lib*. The following are approximately the quantities of meal required:

At	60 lb. live weight :	2 lb. per head per day.
"	110 " " "	3 " " " " "
"	150 " " "	4 " " " " "

(d) In the Wye Trials, 4 parts of barley meal and 1½ parts of flaked maize were the cereal meals used. They may be replaced wholly or partly by maize meal, wheat meal, tapioca meal, or other carbohydrate food.

(e) White-fish meal was the protein feed used in the Wye trial. Meat meal, or whale-meat meal may take its place, as may soya-bean meal, decorticated ground-nut cake or meal, bean, pea or gram meal, etc., if 1½ lb. ground limestone or chalk and ½ lb. of salt be added per cwt. of mixed meal.

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Green Food. The simplest of all methods of supplying green food is to allow the pigs free range over pasture. The grass they eat will not be missed if they are run in small batches in conjunction with other stock. The feeding value of pasture grass deteriorates rapidly during the autumn, but if, as the amount of keep decreases, it is supplemented by cabbage, kale or rape, pigs can be carried on reasonably good grass into the late autumn with an insignificant area of arable green crop.

Indoors, satisfactory results have been obtained with cabbage and kale *when young*. Rape or the surplus from market-garden brassica crops would answer equally well.

Any farmer requiring further information on the subject matter of this article may apply to the author at the Pig Husbandry Research Station, Wye College, near Ashford, Kent.

NOTE. A "Growmore" Leaflet, No. 7, *Pigs in War Time*, has been issued, and single copies are obtainable free on application to the Ministry.

SHEEP IN WAR TIME

J. G. STEWART

Of our farm animals the sheep alone could face a long war without a ration card. Roaming the open field or the mountain side she can find practically all the sustenance she needs from the green earth; her mouth, the most economical mowing machine, her stomach, a wonderful contrivance for converting into human food the natural herbage which might otherwise be wholly wasted. Britain's mutton far more than her beef is the true produce of Britain's soil.

There are about 30 million acres of agricultural land in England and Wales. Of this, about $5\frac{1}{2}$ million acres are rough grazings, nearly 16 million acres are permanent grass and less than 9 million acres are arable. Included in the arable are a further 2 million acres, or thereabouts, of temporary grasses, so that, altogether, over 23 million acres out of the total of 30 million acres are in grass.

With the possible exception of New Zealand, England is acknowledged to be the best grass country in the world, and next to New Zealand, too, it carries the densest sheep population, about 18 millions, including about $8\frac{1}{2}$ million ewes. Sheep thrive best when run along with other farm animals. A safe number of ewes for most kinds of farms carrying a mixed stock of cattle and sheep is generally believed to be 1 ewe to 2 acres. On this basis there is ample scope for an increase in numbers. Indeed, in 1867, when the first annual returns were recorded, the total number of sheep exceeded 22 millions. It is unnecessary, however, to argue from statistics: the emptiness and overgrown condition of the fields in most parts of the country are evidence enough of widespread understocking.

There is just about the same total number of sheep now as there was in 1914, and there are nearly 2 million acres more of grass. It would seem from this that even if $1\frac{1}{2}$ million or more acres are returned to the plough, present numbers of sheep at least could be maintained, and surplus pasturage turned to useful account. Besides being "the stud farm of the world," Britain is, in many parts, just as well, or better, adapted for corn, roots and vegetables as for live stock. Such crops as wheat, oats and potatoes produce much more food than ordinary pasture, and formerly, along with sheep, occupied much larger acreages than they do now. Crops and stock, arable and grass, are not antagonistic. They are complementary. Fitzherbert (1598) puts it this

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way: "A husbende can not well thrive by his corn without he had other cattell, nor by his cattell, without corn. For else he shall be a byer, a borrower or a beggar." Live stock not only make possible, and cheapen, the production of grain and other vegetable foods, but they constitute a real reserve.

The first condition of health in farming as in everything else is balance and proportion. Mountain breeds of sheep are essential for the maintenance of lowland flocks, and they are specially valuable for another reason. They utilize vast tracts of hill country which otherwise could make little or no contribution to the feeding of the nation. At one time their contribution was much greater than it is now. The uncultivated hill was an annexe of the cultivated valley, the lower ground providing shelter and winter food and the hills abundance of natural summer grazing. Economic factors have led to gradual deterioration of the pastures: men have gone, cattle have gone, bracken has invaded the better, deeper soils and hill grazings, and hill flora have extended down over marginal arable land. Not only cattle but wether sheep also have vanished from the hills. The herbage in consequence has coarsened and lost much of its feeding value so that ewe hoggets have to be wintered away and soon even ewe stocks may have to be turned off the hills for the winter. Any policy that encourages the ploughing of marginal land should improve facilities for wintering sheep and tiding over the lambing season. The essential and practically the only food requirement of hill sheep throughout the year is pasture, but it must be reasonably good pasture. The figures below relate to an experiment conducted by the Rowett Research Institute with Blackface sheep from its experimental hill farm in Argyllshire, in 1929-30.

It seems clear that the low productivity of the sheep on the Garrochoran farm, typical of many other hill grazings, is a fault of the grazing, not of the sheep. Wherein does this fault in the grazing lie? Subsequent experiments over a period of six years showed no improvement in productivity as a result of feeding maize, bran, minerals, vitamins, or dried grass. Moreover, the low productivity could not be attributed to losses from any infective disease. The investigators suggest that the general poverty of the pasture in late winter and early spring is the real difficulty that must be faced. The ewes are in good condition in autumn, weighing about 90 lb. By tupping time they have fallen back

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	Garrochoran Flock (not artificially fed)	Cast ewes from Garroch- oran flock taken to Aberdeen and mated with Garrochoran ram (pastured, with hay only during a few days of storm)
Number of ewes put to tup..	445	64
Percentage mortality of ewes	11.43	3
Average weight of lambs at weaning	44 lb.	66 lb.
Number of lambs weaned per 100 ewes tupped	44	87
Average fleece weight (un- washed) of ewes	3.5 lb.	4.5 lb.

in condition to about 80 lb.—one very probable reason of the low lamb yield. By the time the ewe is ready to lamb she may weigh only 60 lb., and after lambing 50 lb. She comes to her lactation when at her weakest. She picks up during the summer, but the same annual ordeal for four or more successive years imposes an unbearable strain on her constitution. To a less degree a wether sheep will lose weight during winter and yet improve through summer to be fat by autumn. It may be that the exigencies of war will necessitate a return to wether mutton from the hills, formerly regarded, anyway, as a delicacy, but this should be accompanied by the improvement of adjacent lowland grazings.

The fundamental importance of sound and sufficient hill stocks cannot be over-estimated. They not only outnumber all other breeds put together but they are also the source from which most lowland flocks are renewed each autumn. The decline of arable sheep farming in the south and east of England and with it the diminution or virtual extinction of some of the Down or other regional breeds has in large measure been counteracted by the infiltration of "flying" pastoral flocks whose nursery is the hills. These flocks are, in the main, the result of a cross of Border Leicester, Wensleydale and Kerry Hill rams on Blackface, Cheviot and Welsh Mountain ewes. They possess the hardiness and good mothering qualities of the hill breeds and the ability, when put to a Down ram, to produce and fatten, mainly off the grass, something like 150 lambs per 100 ewes, a figure rarely approached by any pure lowland breed unless it be the Border Leicester or Dorset Horn.

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The ewes are wintered almost entirely on grass which otherwise would be unstocked or at best carrying a few store cattle helped out by hand feeding. About one month before lambing it has been customary with flocks breeding in February to give a little concentrated food, e.g., $\frac{1}{2}$ -1 lb. per head per day of some such mixture as 2 parts oats, 2 parts bran and 1 part oilcake. Many flocks, however, lamb down successfully even in February on good hay, rock salt and free range. In such circumstances some artificial feeding is necessary after lambing, but the ration can be made up of home-grown or other products commonly not required by man, e.g., oats, bran, linseed cake (or linseed) beans and peas. For stimulating the milk flow nothing can fully take the place of fresh green grass, hence the importance of stimulating an "early bite" or, in its absence, making sure of an adequate supply of kale, mangolds or sugar-beet pulp. Short supplies of feeding stuffs may lead to some reduction in the numbers of early fat-lamb. The consequences are likely to be later lambing, heavier marketings in summer and autumn, and relatively short supplies of fat lamb in the first months of the year. Moreover, there will inevitably be a considerable carry over of store lambs into the winter. The more forward of these will be finished with the help of arable crops. Indeed, should arable farming revive, folding sheep may regain their rightful place. The fattening of the leaner and smaller lambs will create a new problem for many farmers, the complete solution of which may involve to some extent a return to the practice of fattening wethers on summer pasture. Small lambs of hill breeds can be fattened sufficiently in winter to killing "finish" on good clean lowland pastures. Lean lambs will fatten more readily in airy sheds than on over-sheeped pasture or a wet fold. They will require the usual quantities of hay, kale, roots or beet pulp supplemented by about 1 lb. of concentrates, and access to water and rock salt. The concentrate mixture may consist of 2 parts cereal meals or milling or brewing by-products and 1 part of protein-rich cakes, beans or peas. Other lambs will have to be carried through the winter on pasture supplemented with hay in stormy weather and fattened on summer grass. They may lose some weight in winter but will pick up quickly when the grass comes.

A better balance in the marketing of lambs could be attained if in suitable circumstances more use were made of such

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breeds as the Dorset Horn. Normally, there are two "flush" periods for grass—spring and autumn. The former is the more general and the more productive and, therefore, spring is the more suitable breeding season. An adequate stocking of ewes and a thriving crop of lambs are sure means of preventing pastures from running to seed. But there is scope, too, for autumn lambing and a greater utilization of ewes which will breed "out of season." This character is restricted almost exclusively to Dorset Horns and Dorset Horn crosses. The female progeny of the Dorset Horn ram and the Scotch Half-Bred ewe is a handsome, thrifty, hornless sheep, adapted to grass land, which will breed either in spring or autumn or at both seasons. This cross has been adopted and become popular in some districts doubtless for the reason that Scotch Half-Bred ewes (Border Leicester x Cheviot) are more numerous than other pastoral sheep. It is curious that nobody seems ever to have attempted to cross the Dorset Horn ewe with the Border Leicester ram. Theoretically, this should be the breed par excellence, combining, as it would, the two highest propensities for milk and fertility found among individual breeds. Moreover, both male and female progeny would be hornless, an advantage of some importance where horns are apt to get "caught in a thicket."

It is a mistake, however, to attempt to carry a sheep too heavy for its environment. Even in peace it is not uncommon to see Half-Breds where Cheviots would be more appropriate. The latter will winter well on poor lowland grass where the former would practically starve unless hand-fed with hay and corn. In war it may well become necessary to reconsider breeds in the light of local circumstances and available food supplies. Of this we may be sure: there are few farms, arable or grass, where a permanent or temporary flock cannot be usefully fitted into the general economy. Moreover, on the lighter arable farms, the consolidation and uniform manuring derived from sheep are indispensable for successful corn production.

Finally, a reasonable number of sheep introduced to clean land will pleasantly surprise beginners by the way they thrive, and will encourage them to tackle and overcome the little troubles that will almost inevitably arise sooner or later. The more diversified the cropping and the stocking, the more hygienic the husbandry, and the fewer the troubles are likely to be.

BEEF PRODUCTION IN WAR TIME

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Cattle share with sheep the distinction of being the only domestic animals that can convert large quantities of home-grown "roughages" into meat without the necessity of feeding a lot of concentrated food. Indeed, many cattle and sheep are fattened in this country every year on a diet comprised exclusively of grass without the aid of any sort of supplementary feeding. This valuable characteristic has been recognized officially as regards sheep, and farmers have been asked to increase their flocks as rapidly as possible in order that a greater number of sheep may be available for the conversion into meat of grass which could not be used to such good advantage in any other way.

The problem is less simple with cattle. It is impossible to increase cattle stocks at all rapidly; one calf a year is the most that can be expected from each cow, and less than half of these will be heifers, which will be getting on for three years old by the time they themselves begin to breed. Clearly, therefore, to increase the cattle population is from the nature of things a slow process.

Further, the cattle of this country, as distinct from the sheep, are not bred for a single purpose only. Sheep are produced here to-day mainly for the sake of their mutton; except, perhaps, on infertile hill grazings, wool is a secondary consideration. Some of our cattle are bred exclusively for beef, but they are a minority and the majority are bred with the dairy in view. Dairy-bred cattle cannot convert roughages into meat with the same efficiency as those that are beef-bred, and the same is true, but to a less degree, of dual-purpose cattle, the degree depending upon how far these cattle incline towards the beef or dairy side of dual purpose. It seems very important that increased attention should be given to the breeding and rearing of cattle likely best to adapt themselves to the exigencies of war-time farming.

It is impossible to overestimate the value of beef-bred cattle for meat production at this particular juncture. They, and they alone, are capable of converting large quantities of home-grown roughages into first-class beef without the aid of con-

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centrated food. The way in which beef-bred cattle will thrive and even fatten on a diet which will barely suffice to keep a dairy-bred beast in ordinary store condition has to be seen to be believed. Nobody who has fed both types of cattle side by side will doubt the truth of this statement. It seems altogether wrong, therefore, at the present time to slaughter such cattle at too early an age, fattening them on a ration which includes a high proportion of cake and corn. In such circumstances they are dead before they have been allowed to realize their most valuable potentiality—the potentiality inherent in all beef-bred cattle, and in beef-bred cattle exclusively—the capacity to make a really first-class carcass of mature beef on a diet in which cake and corn are either absent or form only a small fraction. To make cattle which are pre-eminently adapted for dealing efficiently with home-grown fodders into baby beef is at all times wasteful and at the present time deplorably wasteful. They should be fed on to weights of 12 cwt. or more, a weight which they will attain economically, using in the process material which could not be utilized to greater advantage and making at these weights excellent carcasses of beef. Moreover, under war conditions it is quantity rather than quality of meat that is required.

The true economic function of the dairy-bred calf is veal. This is generally recognized and in peace time few would attempt the rather unprofitable task of attempting to make it into beef. For the purpose of veal such a calf is as good as, and perhaps even better than, a beef-bred one, which no intelligent man would dream of wasting in this way. In existing circumstances, however, milk-bred bull calves should, for the most part, be disposed of as "bobbies"; and among dairy herds, only those calves well developed from the beef side should be carried to beef weight. Veal production should be undertaken only where the economy of the farm is linked up with this form of enterprise.

In normal times, the dual-purpose calf (with the exception of the more beefy type of dual purpose) is better adapted for baby beef than for the more mature category. This is perhaps not generally so fully recognized as it should be. If fed to attain a weight of 8 cwt., at 16 months' old the carcass is all that can be desired. But a dual-purpose calf is not so profitable if reared to maturity, for under these conditions not only is it a much harder feeder than a beef-bred one, but it

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rarely makes a really first-class carcass of mature beef. Baby beef, however, is certainly not to be recommended in war time, in fact quite the reverse, for it involves the use of very large quantities of concentrates and does not achieve the much desired end of converting a high proportion of home-grown foods into meat. First-class beef is not so essential in war time, however, and, where possible, dual-purpose animals should be kept on to make more meat.

The true economic function of the beef-bred calf is mature beef, made without a lot of extravagant feeding, and allowed to mature in a natural way. For this purpose it has no rival, and in war time is of peculiar value. Unfortunately, cattle of this type are scarce. If only they were plentiful the problem of beef production in war time would be a simple one; in fact there would be no problem at all, for such cattle almost fatten themselves! The problem that faces us arises as a direct result of the type of store cattle with which we have normally to deal, dairy-bred most of them, with few of those characteristics which have been described as making the beef beast so valuable.

In times of peace and plenty the problem is not difficult of solution. With an almost unlimited supply of comparatively cheap cake and corn, it is relatively easy to devise rations upon which such cattle will fatten more or less readily. But with cake and corn available in limited quantities only, and these restricted supplies required largely for other and more pressing needs, the solution is by no means obvious.

It seems probable that many cattle that would ordinarily be fattened in yards or boxes this winter will be run on as stores and fattened out on the grass next summer instead. And, no doubt, where the quality of the grass that is likely to be available justifies it, there is a great deal to be said for this. After all, the cattle will be six months older and, being older, will fatten all the more readily. A ration which will suffice just to grow cattle is one thing, a ration which will fatten cattle is another, while a ration which is capable of doing both simultaneously is yet a third. And it is this last that is so expensive in concentrated food. A store ration need not include any cake or corn at all; a fattening ration suitable for mature cattle, provided roots and hay or silage are available, need contain very little, but if young, immature cattle are to be fattened the ration must include a much higher proportion of concentrates.

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It appears, therefore, that in war time there is a great deal to be said for a prolonged store period, followed by a fattening period which also may be longer than usual. In this way cake and corn are economized and more use is made of home-grown grass, hay, roots and straw. It will result in cattle considerably larger than the average that the market welcomes normally, and the cattle will, of course, be at least six months older than they are as a rule when they are slaughtered. But the country will gain more beef at a smaller expenditure of concentrates.

To postpone the feeding of cattle until next summer will not always be advisable. Unless the grass available is of good quality, no saving in concentrates will result from an attempt to fatten them on it. In fact, there is no method more extravagant in cake than this of fattening cattle on poor pasture. On the other hand, there is no method more economical of cake where the grass is sufficiently good, and there are far more grass fields capable of fattening cattle, if given an opportunity, than is commonly supposed. Particularly is this true of young pastures on poor clay soils, which, if well managed are infinitely superior for this purpose to old pastures on similar soils, however generously and well the latter may have been treated. This the writer can testify from personal experience, having successfully fattened cattle for the past few years without cake or corn on several such fields, fields which as arable land were rented previously at only a few shillings an acre.

If it is decided to store through the winter a bunch of cattle which in ordinary circumstances would have been fattened, it is much better that these cattle should be outwintered if possible, particularly if suitable land is available. Better, that is, from the point of view of the health of the cattle, better from the point of view of the rapidity with which they will fatten with the advent of the grass in the spring, and better, too, from the point of view of the farmer's pocket, for cattle can be wintered very cheaply in this way and may do a great deal of good to rough, undergrazed pastures. Of course, if the treading of straw into farmyard manure is their main purpose the question of outwintering does not arise.

Finally, what advice can be given to the farmer to whom none of the alternatives applies, the big arable farmer with little or no grass land, who is accustomed to fatten large numbers of cattle in yards every winter on roots and straw

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augmented by a generous allowance of cake and corn? For one thing, such a man will be wise, as has already been pointed out, if he attempts to fatten only his largest and oldest cattle and keeps his younger ones as stores. They will sell readily in the spring, and will probably pay better in this way than to attempt to fatten them with the necessary quantity of concentrates unavailable.

In the absence of adequate supplies of concentrates, a farmer may have to be content with a much slower rate of fattening than would usually satisfy him. Instead of fattening two lots of cattle out of his yards in the winter as may have been his custom, he may have to be satisfied with one only. If roots are plentiful—and, fortunately, it has been an excellent root year—large quantities may be fed with a marked saving in starchy concentrates, and if a certain amount of seeds hay can be spared the protein-rich cakes may be reduced too. In any case the protein requirements of the mature fattening bullock are small, and the rations which have been customary during the last decade have generally supplied a good deal more than has actually been necessary. High-protein cakes having been cheap, there has been no inducement to economize in this respect. If rapid rates of gain are not required, it is possible to fatten cattle during the winter on rations which contain small proportions of those foods which in these days it is so necessary to use economically. To suggest actual rations designed on these lines is beyond the scope of this article, even if it were desirable, but County Organizers will be ready to help farmers to design rations to meet their own particular circumstances.

Some of the suggestions that have been made appear to assume a plentiful supply of grass. Many farmers will object that County War Executives are doing their best to reduce the amount of grass land! In some few instances this is undoubtedly a valid criticism, but it must be remembered that in the days before the present war most of our grass land was grossly undergrazed. Thus, more feed from a reduced acreage is by no means an impossibility, whilst heavier stocking will undoubtedly improve the quality of the grazing.

FEEDING THE DAIRY COW IN WAR TIME

W. G. R. PATERSON,

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Under normal conditions, the home production of milk fully meets the demand for liquid milk for consumption as such, and the surplus provides about 30 per cent. of our cheese and 10 per cent. of our butter as well as a quantity of condensed and dried milk. In this production farmers have relied to a very great extent on feeding stuffs from overseas, to the neglect of home resources. The war has revealed the main weakness in this policy, namely that, with a relatively small acreage of arable land, we are normally short of winter keep. With reduced imports of feeding stuffs, a reduction in our milk supplies is inevitable unless we modify management and cropping systems so as to meet requirements largely from home-grown crops.

The considerable variation in the yield and quality of the milk from individual cows in any dairy herd clearly indicates that factors other than feeding influence milking capacity. The potential yield is in the first place largely determined by breed rather than by feed. Feeding, no matter how generous, will not convert a poor yielder into a high producer; the most it can do is to enable the cow to yield right up to the limit determined by breeding, mammary development, and capacity to utilize food in the production of milk.

Are High Yields Worth While? In striving for high yields, many dairy farmers are merely following the modern craze for the phenomenal, such as excessive speeds, excessive endurance, outstanding production. We are naturally and deservedly proud of the 2,000- and 3,000-gal. cows—super cows, milk factories in miniature—which are the product of careful selection and breeding coupled with scientific rationing, but no matter how valuable they may prove for advertising purposes or for breed propaganda, they scarcely represent the farmer's ideal. Under present conditions, the feeding of these exceptionally high producers is likely to prove much more difficult since, in order to keep down the bulk of the ration, a much greater proportion must consist of concentrates, of which only a relatively small part is grown on the farm.

At the risk of being misunderstood, the writer affirms that there is, even under normal conditions, and still more so under

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war conditions, a great deal to be said in favour of cows capable of yielding 700-1,000 gal. under real good management. They can generally be relied on to produce a calf every 12 or 13 months. Their maintenance requirements as well as those of the first, and sometimes even the second, gallon of milk, can be fully met from the ordinary farm crops. They need less individual attention, less humouring, less labour, and twice-a-day milking suffices at all times. Further, experience suggests that they are less liable to common ailments, and generally stand the strain of a greater number of lactations and have a longer effective milking life. Such cows constitute the backbone of the dairy industry, and they are the medium through which an economic market can be found for a considerable proportion of farm crops. How, otherwise, save as milk, beef, mutton, etc., could we get a cash return for much of the grass, hay, straw, roots, silage, etc., that is produced?

Protein—a Limiting Factor in Milk Production. With few exceptions the ordinary farm crops used for stock feeding, though fairly rich in carbohydrates, are deficient in protein. Protein supply is therefore likely to prove the greatest difficulty, particularly with cows giving large yields. Protein-rich foods, such as decorticated ground-nut cake, decorticated cotton cake, soya bean, linseed, white-fish meal, etc., may not now be available to anything like the normal extent.

The problem is made a little more difficult as it has been shown in recent years that quality of protein as well as quantity must be considered. Of proteins from different sources, not all are equally valuable for milk production. The results of investigations have shown that, if we can select our proteins, the amount usually fed can be cut down to some extent without any reduction in the yield of milk or any adverse effect on the animal. With sufficient variety in the ration, this could probably be reduced to 0.5 lb. protein equivalent per gal. of milk without any adverse result. If, however, the range of feeding stuffs is limited, one would hesitate to recommend any material reduction in the amount of protein prescribed some years ago by the special Cow Rationing Committee, namely 0.6 lb. protein equivalent for maintenance of the 1,000-lb. cow and 0.6 lb. protein equivalent per gal. of milk, 3.8 per cent. butterfat.

FEEDING THE DAIRY COW IN WAR TIME

There is a tendency to include rather generous amounts of protein in many so-called balanced rations for supplementing home produce. A number of these that have come under review contain more than 20 per cent. protein, and when fed at the rate of $3\frac{1}{2}$ lb. per gal. for production, provide about 0.75 lb., which is undoubtedly excessive.

If adequate imports of protein-rich concentrates are not forthcoming, it will be during the present winter months, before grass is again available, that our difficulties will be greatest. We can plan and prepare for another winter, but for the present winter we must make the most of such food-stuffs as are available.

Elimination of Unprofitable Cows. This should undoubtedly be the first step. It is true that the number of cows in this category has been reduced in recent years, but on many farms the standard is still low. These low producers do not add to the income of the farmer but take away therefrom. They are not paying guests but boarders who do not pay their way.

Feed in Keeping with Production. A second, and an equally important step is to feed, as far as possible, in keeping with production. If supplies of concentrates are inadequate to meet requirements, the major share might be reserved for the heavier milking cows so that the bulk of the ration need not be so great as to have an adverse effect on production. There is a limit to the amount of food an animal can consume and digest. The problem is partly one of our own making for we have raised the standard of production to such an extent that only a limited amount of the ordinary farm produce can be utilized in the rations of these high producers.

Production of Earlier Grass. Something helpful can also be accomplished by the production of earlier grass in one or two suitable fields. Much will depend on the severity of the winter and on the weather in the early part of the year, but it has been amply demonstrated on the College Farm that the use of fertilizers, and particularly of nitrogenous manures, will generally produce a fairly good bite of grass at least two weeks in advance of the normal period.

Farmyard manure may also be used, but it should be applied in autumn or early winter, otherwise the resultant pasture is not so much favoured by the stock, nor is the

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benefit from the manure so pronounced. A uniformly distributed dressing affords a measure of protection during the winter, keeps the soil warmer, and encourages an earlier growth. Young rotation grass responds to manurial treatment more readily and to a much greater extent than older pastures, and wherever possible a field of young grass should be reserved for the treatment suggested.

The early bite, though exceedingly useful at a time when most succulent foods are used up, has the disadvantage that it is somewhat laxative. The cows should not be allowed to graze it too long to begin with, and their ration should include a reasonable amount of hay, which helps to correct the laxative tendency.

Steps for the Future: Ploughing for Milk. With time to plan we can turn our attention to the production of food-stuffs to replace those formerly imported. This will necessitate putting into operation a policy of ploughing for milk.

With the prospect of supplies of protein-rich concentrates being much reduced, one of our first aims should be to secure a recovery in the acreage formerly under beans and peas, and which fell from 400,785 in 1918 to 215,965 in 1939. Increased production would do much to provide the protein required to enable us to feed a balanced ration and make the most of other home-grown foodstuffs deficient in that constituent but relatively rich in carbohydrates. Beans and peas can be successfully grown either by themselves or in mixture with cereals. The growing of beans and oats as mashlam was formerly a common practice on many farms in the south-west of Scotland.

Beans and oats in equal parts by weight, fed at the rate of 4 lb. per gal. of milk of average quality, constitute a full production ration, and supply the right proteins, the bean ranking high in that respect and making good any deficiency in the oats. The inclusion of 1 part of bran does not materially affect the balance and improves the ration.

The value of the bean in milk production is well known, but its late ripening makes it a somewhat risky crop to harvest, especially in the later districts. Under favourable conditions, sowing in early winter would give an earlier harvest, but the real solution rests on the introduction of an early-maturing, heavy-yielding variety. An early-ripening bean crop would be a great asset to the dairy farmer, and the problem is so

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important that it should receive immediate attention. Meanwhile, we must make the most of the varieties available.

Apart from an increase in the area under beans and peas, increased supplies of oats, roots, turnips, swedes, mangolds, cabbage and kale, also of forage crops for use in the green state or for conversion into silage, would all prove beneficial in the feeding of the dairy herd. One acre of a good forage crop will generally furnish three times the amount of keep that results from an acre of ordinary pasture.

It is doubtful if the value of silage is sufficiently appreciated by dairy farmers. It has a favourable dietetic effect and a specially healthy influence. Through its high moisture content, it is, like the root and green crops, really a source of succulence.

High-grade Dried Grass as a Substitute for Concentrates. High-grade dried grass of protein equivalent in the neighbourhood of 20 per cent. and corresponding high starch value is another protein-rich food of special value in the winter feeding of the dairy herd. Grades of dried grass may cover a very wide range according to the material and the stage of cutting, but for the replacing of protein-rich concentrates a high-grade product should be aimed at. Feeding trials by The West of Scotland Agricultural College have shown that, both with dairy cows and fattening cattle, dried grass on a weight-for-weight basis is at least equal to a well-balanced concentrate ration.

The placing of this food on a sound economic basis is, in the first place, really an engineering problem, but when solved satisfactorily, as it doubtless will be, there will be a very great deal to be said in favour of the installation of grass-drying plant on every large dairy farm on which the capital outlay would be justified. If grass drying could be placed on a sound economic basis it would go far towards solving the problem of the feeding of the dairy herd in winter.

Can We Make More of the Hay Crop? A mistake commonly made with hay is to delay unduly the time of cutting in order to obtain a greater yield. Early cutting is strongly recommended, otherwise nutritional value will be substantially lowered. The weather, of course, is an all-important factor, but at the latest the hay should be cut immediately the pollen has left the flower, and preferably earlier, though it is then more difficult to handle if the weather is unfavourable. If

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cutting is delayed till the crop is ripe, much of the valuable nutrients from leaf and stem will be transferred to the seed, and apart from the hay being more fibrous, the loss of seeds shed during haymaking lowers its feeding value still further.

Is the Rationing of the Dairy Herd on a Scientific Basis? The majority of dairy farmers in the south-west of Scotland have put the rationing of their dairy herds on a fairly sound scientific basis; some, indeed, have reduced it to a fine art. It may be that several are a little liberal in the amounts given—the reason for this is perhaps, in part at least, psychological, and associated with the monthly cheque from the Milk Marketing Board.

In devising winter rations, it is more common to feed a basal ration to meet maintenance requirements than to feed for maintenance and the first gallon of milk, but both methods are practised, and thereafter a ration of concentrates is fed at the required amount to supply $2\frac{1}{2}$ lb. starch equivalent with 0.6 lb. protein equivalent per gallon of milk of average quality produced by the cow. Feeding is thus strictly in keeping with production.

The south-west area of Scotland, though relatively small in size, nevertheless shows great variation in dairy-farming practice. Some dairy farms are practically all grass farms; others are largely arable, and the basal feeding varies in keeping with the nature of the farm. The following are representative of some of the maintenance rations for typical Ayrshire cows of about 9 cwt. live weight. As has already been indicated, the feeding thereafter is in keeping with milk production, a definite additional allowance being given for each gallon of milk produced.

NATURE OF FARM	BASAL RATION FOR MAINTENANCE
A. Farm largely arable	.. Swedes: 40/60 lb. or equivalent as turnips, mangolds, kale, potatoes, silage, etc. Straw: 14 lb. Hay: 6 lb.
B. Farm partly arable	.. Swedes: 30/40 lb. or equivalent in other succulent foods. Hay: 12 lb. Straw: 8 lb.
C. Farm partly arable. Silage made.	Swedes: 20/30 lb. or equivalent green crop. Hay: 10 lb. Silage: 20 lb.
D. Farm mainly grass and hay.	Hay: 20 lb. Dried sugar-beet pulp: 2 lb.

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Under war conditions the above maintenance rations might be somewhat reduced, and, for maintenance and the production of one gallon, the following are suggested for 9-cwt. animals on the types of farms described above:—

				<i>lb.</i>					<i>lb.</i>
A.	Swedes	..	..	60	C.	Swedes	..	..	40
	Straw	..	..	12		Silage	..	..	25
	Clover hay	..	..	8		Meadow hay (medium)	..	..	10
B.	Swedes	..	..	40	D.	Meadow hay (medium)	..	..	24
	Straw	..	..	13		Dried sugar-beet pulp	..	..	3
	Clover hay	..	..	11					

As a guide to economies in the feeding of dairy herds, readers are invited to apply for a copy of the Ministry's special "Growmore" Leaflet No. 8 on the subject.

IMPLEMENTS IN WAR TIME

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Ever since the outbreak of war the farming world has been divided into two camps: those who have been working tractors and ploughs as hard as possible, and those who have tried, with varying success, to buy them. Equipment has been scarce only because everyone has wanted to buy at once. Just as a sudden rush of withdrawals might have caused the collapse of an otherwise sound bank, so a sudden rush of buyers produced, within a few September days, something like an implement famine—and this in spite of the fact that available trade stocks were probably greater in August than they had ever been before.

Ploughs. One result of the shortage has been that long-established opinions about the relative merits of this plough and that have had, temporarily at any rate, to be set aside. In the circumstances any plough has been better than no plough at all. Nor, if one can judge from the preliminary results of a survey of ploughing-up methods which was in progress when war broke out, is this setting aside of peacetime preferences likely to do any harm. For the results suggest very definitely that ability to set and handle an implement properly counts for more than the design of the implement itself. As far as the writer's own observations went, for example, one outstandingly bad job of ploughing was being done with a plough made by a firm of world-wide reputation; but the coulter was badly set, the shares were worn and, above all, the work was being rushed—probably to get it done at a cut price. The plough was hitched so that the front body was cutting far too wide, while, regardless of what was happening to the furrow slice, the rubber-tyred tractor was running away at something over four miles per hour. By way of contrast one can call to mind another scene on a boulder-strewn hilltop in the West Country where humps and hollows of all kinds had to be negotiated. Here the plough in use was by no means the one the writer would have chosen; but because the operator was content to go slowly

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and took the trouble to reset his implement when conditions changed, something like a perfect job resulted. Curiously enough, the man concerned with the first of these instances was credited with a good deal more ploughing experience than the other.

On the whole it is to be expected, and not to be regretted, that the exigencies of war time will complete the process of plough standardization which started with the coming of mechanical power. There will still be different ploughs, but they will be associated with different jobs of work rather than with different localities. Differences in plough fittings, on the other hand, are likely to be more and more appreciated as time goes on. Thus, during last summer some exceptionally good grassland ploughing was done here and there with the aid of special skims and discs. The effect was to pare a wide but shallow rectangular slice of turf from the left-hand side of the furrow-slice—instead of the triangular section cut by ordinary skims—and to “rabbet” the furrow slices together so that no trace of green was left exposed. A step further in the same direction, particularly on land infested with deep-rooting weeds, is the “double ploughing” for which some farmers have contrived their own equipment. Here the general principle is a two-furrow plough of which the rear body ploughs shallow and the front one deep so that the turf is thrown into the bottom of a deep furrow where it is pressed by the tractor wheel before being covered. Then again there are the various possible attachments to the end of the mould-board, of which seaming knives are the most interesting in the present connexion—these “gash” the back of the furrow slice so that it breaks down more readily. Up to now most of these special fittings have been concerned with ploughing land for re-sowing to grass, but they have other applications and, where corn is to be sown, may save at least one after-cultivation. All these attachments, however, tend to make it more difficult for the plough to enter, so that they need careful adjustment and, indeed, are difficult to use on hard baked land. For the same reason, they are always more effective on a heavy plough than on a light one.

Furrow-presses and Disc Harrows. Among cultivating implements whose use is likely to spread, furrow-presses and disc harrows may be specially mentioned. The peace-time distribution of furrow-presses would be an interesting subject

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for a purely academic research: they are more commonly associated with light land than heavy—they are regularly used in Norfolk, Hampshire and Wiltshire for example—yet some light land districts have no use for them, or, alternatively, have never heard of them. On the other hand they are in demand when some of the heavy West Midland clays are ploughed-up, while devices identical in principle are regularly used in Kent. Moreover, there are differences of opinion about the design even of this simple implement: some districts like a smaller diameter than is usual, while according to local preference, a two-furrow plough may be followed by either a two- or three-ring press. But, whatever the exact design, a furrow-press is a very useful aid in grassland ploughing. As for disc-harrows, their outstanding virtue on ploughed-up grass land is that they need bring nothing undesirable to the surface. In general arable farming, where they were once regarded only as “tilth-forcers,” more typical of mechanization than of good husbandry, disc-harrows have now earned a more solid reputation. This is based on their usefulness in a variety of operations, from stubble cleaning in autumn to seedbed preparation in spring—and the wetter the spring the more useful they have proved. The demand for these, and for the other more orthodox implements of ordinary cultivation, is now generally recognized and, although the New Year may bring a new rush of buyers, manufacturers should be able to satisfy all needs.

Row-crop Cultivation. For some other forms of equipment an increased demand may be more difficult to satisfy in advance. Row-crop equipment for use with tractors is an obvious case in point. There is no indication that row-crop acreages will be much increased, though the shortage of hand workers, which was beginning to be serious even in peace time, is bound to be more acute next year. One thing that cannot be foreseen is how farmers themselves will react to this shortage: they may choose to rely on substitute labour, say, from the Women's Land Army; or they may try to short-circuit their difficulties by whole-hearted mechanization. But if they choose the latter course after waiting until April to decide, there will once more be an implement famine. For just suppose that it was known with certainty that, say, 2,000 extra sets of tractor hoe equipment will be needed in the spring: what could be done in advance to avoid a shortage?

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Very little indeed—except to urge farmers to decide on their own requirements in good time—because, except in a very limited way, there is no such thing as standard row-crop equipment. To make provision in advance, one would need to have detailed particulars of the 2,000 tractors to be equipped, and to know a great deal about the actual crops and row-widths to be cultivated. Moreover, before proceeding to plan things deliberately to this extent, it would be only logical to remember that there are still ten times as many horses as tractors in the country, and that in most row-crop work the relative advantage of the tractor is at its lowest. It would probably appear, in fact, that row-crop cultivations in war time ought not to be mechanized at all.

Root Harvesting. The harvesting of root crops is a rather different matter, and it may be worth noting that there are at least three sugar-beet harvesters in limited commercial production, all of which might be more widely used than at present. It is doubtful whether any of them would work on the heaviest land or in the most difficult conditions, but in a normal year they ought to be capable of dealing with at least half of the total acreage grown. Large-scale potato growers have already shown that an implement which will work only when conditions are favourable may nevertheless be well worth having: many of them use conveyor-type lifters during the early part of the season and go back to ordinary spinners when the weather breaks.

Haymaking. The operation, which above all others is likely in ordinary times to lead to a suddenly-increased demand for equipment, is haymaking: although with something over a million acres of grass land ploughed-up there ought to be no shortage of normal haymaking implements next year. But there may be a heavy demand for sweeps, and there will probably be a greatly increased interest in field baling. Since it offers the possibility of making higher quality hay, the latter process has a definite war-time application both in reducing our dependence on imported foodstuffs, and in effecting all-round economy. Experimental work on the subject has been widely extended this year, and it is hoped that the results will make it possible to lay down and control optimum baling conditions with greater certainty in the future. From now on, ram-type balers making high-density wire-tied

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bales will be of greater interest than self-tying press balers since all the latter are of German origin. Wire-tied balers are, moreover, easier to control both in making and storage, while they have the additional advantage of being readily transportable. Up to now, most ram balers have been massive machines too expensive for the average farm but a much smaller model should be available next year.

Harvesting. In the corn harvest we shall have to rely mainly on old-established methods and equipment. Combine-harvesters have proved their worth wherever they have been tried; but they are still too few in numbers to make a very significant contribution to the total acreage cut. Even straightforward threshing from the stook, a process which has many of the advantages and none of the disadvantages of combining, may have to be restricted because of a general lack of storage facilities. But one thing at least is clear: that every binder in the country should be looked over in good time and put in repair. For, however many extra binders may be specially provided, the bulk of the harvest will have to be cut by the thousands of machines already on farms—and all of them will have to work harder than ever before. On mechanized farms it is a part of ordinary winter routine to overhaul harvest equipment, and nothing is left to chance when cutting starts. But the small-farm binder, which very often goes the round of the parish, is often treated in much more casual fashion—so much so, in fact, that an August breakdown is almost regarded as part of the game.

Maintenance. One might, in fact, close this brief review of implements in war time with a general plea that the greatest possible attention should be given to maintenance and to the simple repairs that will save a more serious breakdown later. Due to the equipment that has come into use during the last ten years and the experience of mechanization that has been gained, we are exceedingly well placed to undertake any extended programme of food production that may be required. It should be remembered though that, like the binder, many implements will have to crowd two years of normal work into one, and many more will have to be handled sooner or later by relatively unskilled labour. If maintenance is neglected, the rate of implement replacement may become so high as to offset all that our manufacturers are doing to provide adequate supplies.

FEEDING HORSES IN WAR TIME*

This article deals mainly with the feeding of the working horse on the farm, but the information given, with indicated modifications, is generally applicable to all types of working horses.

The work of the farm can only be satisfactorily done if the horses are given enough to support them. No more and no less should be allowed. Upon the care which is taken to ensure that the horses get no more than their just needs will depend the supplies of food available for other classes of stock, and to some extent even for human consumption.

Horses Not at Work. Idle horses or horses at very light work require no corn or other concentrated food. Under present conditions such animals should be fed entirely on grass, and only in winter, if at all, will they need other food, which should be given in the form of hay and straw, with occasionally a little bran or weatings when the weather is very severe. The same will apply to the working horse in his periods of idleness, if these are prolonged. For slack periods of short duration it will be desirable to maintain the condition of the horse by more liberal feeding, although this should be well below the level of the feeding on working days.

Working Horses. The needs of the horse at work will vary with its weight, the amount of work, and the character of the work it is called upon to do. A heavy horse will need more food than a light horse on similar work, but will be able to consume greater quantities of bulky food such as hay or straw.

In considering the food requirements for the actual production of work, it must be borne in mind that if the food does not provide sufficient energy for this purpose, the horse must draw upon its body-tissues for the necessary balance, with the inevitable result that it will lose condition and rapidly become less efficient. Again, more energy—and therefore more food—is required by the horse doing its work at a fast pace than if the same work be done at a slow pace.

* This article is reprinted as "Growmore" Leaflet No. 12, single copies of which may be obtained free from the Ministry.

FEEDING HORSES IN WAR TIME

Further, since the fast-moving horse must be able to draw on supplies of energy more quickly, it must receive its food in more digestible form; in other words it must get more concentrated food and less coarse fodder. Briefly summarised, the horse must be fed according to its weight, the amount of work set for it, and the rate at which this is to be done. Generally speaking, the heavier the horse and the slower the rate of working, the greater may be the proportion of bulky fodder (green stuff, hay, straw, chaff and roots) in the ration, and the smaller correspondingly the proportion of concentrated food required.

The foregoing considerations must be kept in mind in considering the examples of rations given below, which are intended to apply to the farm horse of average weight, say about 14 cwt., doing an ordinary, not very severe, day's work. Light horses will require one-third less, and the heaviest horses about a quarter more, hay and straw. The latter should also get a little more corn or other concentrated food than the amounts suggested when their work is very severe.

The total requirements of the "vanner" or other medium-weight horse doing considerable work at a fair pace, will be roughly those of the average farm horse, but the proportion of concentrated food to hay and straw should be greater.

Food for Average Conditions. For such average conditions the total food supply per horse per day, including the dry matter or any green stuff or roots fed,* should be 28-36 lb., the higher figure being approached where straw is fed in appreciable quantity. In normal times roughly one-half of the ration (or rather more if straw be fed) would consist of coarse fodder and the rest concentrated foods. Now, however, it is essential that the proportion of coarse fodder should be increased as far as is consistent with efficiency, and the supply of corn or meal correspondingly reduced. For this purpose $2\frac{1}{2}$ lb. of good hay or 4-5 lb. of oat straw may be regarded as roughly equivalent to 1 lb. of corn or other concentrated food.

Undoubtedly, economy of food is effected by chaffing at least a portion of the hay and straw, since not only is there

* The dry matter in green stuff and roots may be taken at one-fifth and one-eighth respectively of the weight of the fresh material.

FEEDING HORSES IN WAR TIME

then less direct waste of the coarse fodder, but a more efficient mastication of the concentrated foods can be ensured by mixing them with the chaffed fodder. Further, although many horse-keepers prefer to feed oats whole, there can be no doubt that when fed in this way they are very often imperfectly digested. It is desirable, therefore, under present conditions, that oats should be crushed before feeding. This should certainly be the invariable practice for horses with bad teeth, and for "bolters."

The Use of Roots. The suitability of roots for horse-feeding must also be emphasized, but these should be used, for the farm horse at any rate, to reduce the consumption of corn and meals, and not as substitutes for hay and straw. The most suitable roots are carrots, mangolds and swedes. In present circumstances, where carrots and swedes are in demand for human consumption, mangolds, if available, should be preferred for horses. For the foregoing purpose 7 lb. carrots or 9 lb. swedes or mangolds may be taken as roughly equivalent to 1 lb. of oats or mixed meals.

With regard to the allowance of concentrated foods, it is highly desirable that the consumption of oats by horses shall be reduced, and, further, that other materials, such as maize, beans and peas, which can serve for direct human consumption shall be drawn upon as little as possible. In general, the aim should be to include in the ration the minimum of concentrates, of whatever kind. Much may be done to keep their consumption within very modest limits, if full use is made of the various alternative feeding stuffs which have been found by experience to be safe and satisfactory for horses. In addition to using the maximum proportion of the more bulky foods, there are a number of alternatives to oats and other corn which may be fed with advantage, such as wheat bran, weatings, dried brewers' grains, malt culms, maize gluten feed, linseed, linseed oil, linseed cake and meal, palm kernel cake and meal, coconut cake, groundnut cake and molasses. Rice meal, when available, is also very useful. The amounts of most of these which may be usefully included in rations are indicated below.

Typical Rations. The following rations are intended to be regarded as equivalent to the oats in a ration of 14 lb. hay + 14 lb. oats. The hay may be partially replaced by straw

FEEDING HORSES IN WAR TIME

in the proportion of 2 lb. straw to 1 lb. hay, up to a maximum of, say, 10 lb. of straw. On some farms where straw is abundant and of good quality it is used exclusively. It is very desirable that straw should be used to the fullest extent. Roots to the extent of 7-14 lb. should be included when available, and especially when the corn ration is of a "binding" nature, the allowance of corn or meals being then reduced by 1-2 lb.

(A) RATIONS INCLUDING 10 LB. OATS :

Oats	10 lb	Oats	10 lb.	Oats	10 lb.	Oats	10 lb.
Maize	1½ "	Rolled		Wheat		Palm Kernel	
Peas or		Wheat	2½ "	Bran	3 "	Cake or Coco-	
Beans	1½ "	Dried		Sugar-beet		nut Cake	1½ "
		Grains	2 "	Pulp (dry)	1 "	Bran	1½ "

(B) RATIONS INCLUDING 5 LB. OATS :

Oats	5 lb.	Oats	5 lb.	Oats	5 lb.
Rolled Wheat	3½ "	Wheat Bran	3 "	Malt Culms	3 "
Beans or Peas	3 "	Sugar-beet Pulp		Weatings	3 "
		(dry)	2 "	Maize	1 "
		Dried Grains	4 "	Peas or Beans	1 "

(C) RATIONS WITHOUT OATS

Rolled Wheat	5 lb	Dried Grains	6 lb.	Dried Grains	5 lb.
Dried Grains	5 "	Maize gluten Feed	3½ "	Weatings	5 "
Beans or Peas	3 "	Palm Kernel Cake		Beans or Peas	2½ "
		or Coconut Cake	3½ "	Maize gluten	
		Crushed Linseed	4 "	Feed	2 "
		(or 4 oz Linseed Oil)			

In drawing up other rations, the various feeding stuffs may be assumed to be roughly equivalent to oats in the following proportions :—

10 LB. OATS =

7½ lb.	Maize
8 "	Rolled wheat.
9 "	Beans, peas, barley, sugar-beet pulp (dry), oil-cake, or maize gluten feed.
11 "	Weatings.
12 "	Bran, dried grains, or malt culms

Foods not known to be safe should not be included in the ration in greater quantities than 2 or 3 lb.

POULTRY KEEPING IN WAR TIME

JANET W. STRANG,

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It has become clear that during the war poultry keepers are not likely to have at their disposal the same kinds and quantities of feeding stuffs as in times of peace. Already we have had temporary shortages of several customary foods, and with the uncertainty of imports and difficulties of distribution, shortages may become more acute. Any development in poultry keeping to be encouraged under existing conditions should, therefore, be mainly in two directions—the keeping of a small number of birds by householders and cottagers to utilize kitchen and garden scraps, and larger numbers on general farms, where poultry can be kept on free range and can forage for much of their food. It is to be hoped that, in addition, the best of the pedigree breeding stocks throughout the country will be maintained, even if they are not kept under mixed farm conditions. But with these it is essential that the owners should effect a substantial saving in their purchased foods. One way of doing so, which may be recommended from a national point of view, is to cull the flocks rigorously, removing all birds which are unthrifty or below standard.

For small-scale poultry-keeping by householders and cottagers, the most economical number of birds will depend upon the size of the household, and also on the quantity of surplus vegetables obtainable from the garden. A unit of 6-12 birds will usually be sufficient. To make the best use of household and garden scraps, a “stock pot” should be boiled daily for the poultry. Into this should be put small potatoes, potato parings, cabbage leaves, turnips, greens, or almost any kind of vegetables which can be spared from the garden; also egg shells, dry bread, meat scraps, bacon rind, or other kitchen by-products. Anything excessively salt should be avoided. Half a dozen or so birds could be kept almost entirely on this food with just a small quantity of bran or middlings added, to make the mixture dry and crumbly.

With regard to poultry keeping on general farms, there is no doubt that where the farmer makes the best use of the facilities at his disposal, the mixed farm is the ideal place for poultry. The right number of birds will depend upon the area of suitable land, and the amount of time and attention which can be devoted to the business. For the present, it would

POULTRY KEEPING IN WAR TIME

probably be best for the ordinary farmer starting poultry keeping to limit his birds to not more than a few hundred. Where a general farmer is already established in poultry keeping on a larger scale, and has an extensive area of land—much of it arable—at his disposal for poultry, with an adequate supply of grain of his own growing available for the birds, he might manage to carry on at full capacity. Comparatively small units, spread over as many farms as possible, would seem to be the ideal method of maintaining the poultry population with the minimum demand upon imported or other concentrated foods.

Fresh, clean ground has an enormous influence on the health of stock. Temporary leys, which are being encouraged, provide ideal conditions, so that the poultry-keeping methods which are to be adopted should, as far as possible, fit in with "plough-land." Easily movable houses, each taking a moderate number of birds, are best. Folding units do very well, provided the land has a sufficiently level surface, which is usual on land that has been fairly recently under the plough. On old ridge-and-furrow grass land, which is common in the Midlands, slatted-floor houses have proved more suitable. These can be mounted on skids, or on wheels if a specially strong axle is provided.

Where foxes are troublesome, it may be an advantage to arrange slatted-floor houses in a row in a field, with a movable wire fence, such as was described in this JOURNAL in May, 1939 (p. 163). The houses are moved within the enclosure weekly, and the entire enclosure, which may cover several acres, is moved every few months. As well as providing protection, this system ensures that the land is evenly manured, and keeps the birds out of the ditches and hedges, where they can do much damage.

As regards feeding, there are many ways which farmers might improvise. It is generally agreed that actual and potential breeding stock should have a proportion of corn of some kind in their ration. If first-quality cereals are not available, there is usually a certain amount of dredge corn, tail wheat, oats or barley which could be given to the poultry, but if there is not enough of this for all the birds, it should be kept for the breeders, and purely commercial birds fed entirely on mash. The ordinary type of laying mash consists roughly of 10 per cent. animal protein, 30-40 per cent. mixed cereal meals, and 50-60 per cent. millers' offals. Under war con-

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ditions, farmers cannot expect that normal ingredients will be available, and the fullest use should be made of substitutes; for example, *part* of the cereals may be replaced by boiled potatoes, and *part* of the millers' offals with boiled swedes and green vegetables. When boiled vegetables are used, the mash should be thoroughly incorporated with the vegetables after they are boiled; the birds eat the vegetable matter more readily if fed in this way. A more difficult problem would arise if no purchased meals whatever were available. Even then, however, comparatively small flocks could still be maintained on mixed farms, if fed almost entirely on home-produced foods, although maximum production could hardly be expected. A mash used successfully at Moulton during the last war consisted of:—

Parts by Measure

Potatoes (boiled)	..	..	..	..	..	2
Green Vegetables	..	..	..	..	..	1
Bran	..	..	..	..	..	1
Fresh Blood	..	..	..	..	..	1

Although bran was included, sharps or middlings, or even ground wheat or ground dredge corn, would serve quite well. This proportion of meal ensures that the mash can be fed in crumbly condition, and it is important that it should not be sloppy. An alternative to fresh blood is separated milk, which is actually superior. This can be given either in place of drinking water or mixed with the mash. Failing blood or milk, butcher's offals, thoroughly well boiled and afterwards chopped into small pieces, would form a useful source of animal protein. Moreover, if poultry are kept in quite small numbers distributed over the farm, it is surprising how much animal protein in the form of insect food they can find for themselves. We have found repeatedly that the poultry on a certain field giving access to low ground in which are a pond, a stream and some undergrowth, find so much in the form of insect and small animal food, that it has proved better to cut out protein-rich food, such as fish meal, from their rations while they are there.

There is some difference of opinion with regard to the need for cod-liver oil, but it is agreed that it is essential for birds kept intensively. It is commonly used for breeding stock and young chickens, but these can do without it, provided they have access to a grass run and are frequently moved to fresh ground. On the Institute Farm, cod-liver oil has not been

POULTRY KEEPING IN WAR TIME

used for the past two years except for intensively kept birds. In the event of a real shortage, it would be necessary to change over to an outdoor system, providing an ample supply of green stuff.

With poultry on range, the birds should be let out as early as possible in the morning, but not fed till about nine o'clock. This encourages them to forage for themselves. At nine, they could be given about $1\frac{1}{2}$ oz. of corn* per head, if available, and in the late afternoon, as much mash as they will readily clear up. If corn is not available, then two feeds of mash of the vegetable-blood-meal sort, described above, could be given. In winter, the birds should have swedes, to peck at during the day. A convenient way to feed swedes, is to cut them in two, and stick each piece on a nail driven into the side of the poultry house, with the cut surface facing outwards.

As regards maintenance of flocks, there is a minor matter which may call for adjustment under war-time conditions. Ordinarily, the more progressive poultry keepers cull out and sell about 50 per cent. of the pullets at the end of their first laying season. The reason is that second-year hens lay fewer eggs than pullets, and a greater proportion of the eggs are produced when normally lower prices are ruling. If, however, during the war, egg prices should be more stabilized throughout the year, it may become worth while to keep more hens for their second season's production.

Summarizing, the ploughing-up scheme favours poultry keeping by farmers, in that it provides specially suitable conditions for poultry in the form of temporary leys. Moreover, if farm poultry are accommodated in easily portable houses, they can be moved frequently, thereby ensuring clean, healthy ground, the ready utilisation of "shed" grain on the stubbles, and to some extent, the reduction of grubs and insect pests, particularly when the poultry are run over newly turned furrows.

If foods, especially foods rich in animal protein and minerals, are to be scarce or unobtainable, then the natural animal protein which ranging birds can find for themselves, and nature's fresh green food, will go a long way towards providing the necessary vitamins, and making good the deficiencies in war-time rations.

* The Ministry has published a leaflet—"Growmore" Leaflet No. 2—on alternative grains that may be used in Poultry Feeding, copies free on application to the Ministry.

HINTS ON FEEDING

H. E. WOODMAN,

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It is now clear that we must be prepared for a marked reduction in the supply of cereals available for stock-feeding during the coming months. What foods, then, are the best substitutes for cereals in farm rations? The answer is: root crops, potatoes and sugar-beet pulp.

Both plain and molassed beet pulp can replace cereals in the rations of sheep and cattle, and generous amounts, if available, can be used, 1 lb. of beet pulp being equal to 1 lb. of oats, $\frac{9}{10}$ lb. of wheat or barley, or $\frac{4}{5}$ lb. of maize. Molasses itself, containing 60 per cent. of sugar, can also be used to eke out a shortage of cereals for pigs as well as cattle, but it should be used only in moderate amounts, and if scouring should be noted, the proportion in the ration should be reduced forthwith. Two lb. of molasses is equal to 13 lb. of roots or about $1\frac{1}{3}$ lb. of cereals.

For the feeders of pigs and poultry, who will be affected most by the restriction of supplies, boiled or steamed potatoes are the best cereal substitute, 4 lb. being equivalent to 1 lb. of cereal meal. On this basis they may replace up to 40 per cent. of the total ration, whilst artificially dried potato meal may similarly form 25-30 per cent.

The use of roots as a source of carbohydrate for sheep and cattle is too well known to require special comment, but it may be pointed out that boiled swedes or mangolds may also replace one-fifth of the rations of pigs and poultry, 9 lb. of swedes or 12 lb. of mangolds being equal to 1 lb. of cereal meal. The boiled or steamed roots should be mashed up with the meal part of the ration before feeding.

Wheaten offals will also be below normal supply in the coming months, but the restriction will not be so serious as with cereal grains. This again will particularly affect the pig-feeder. The pig should have first call on available middlings, particularly the young baconer, but the allowance need not exceed 30 per cent. of the total ration. Beyond 100 lb. live weight, part of the middlings and cereal may be replaced by ground oats (up to 25 per cent. of the ration) or by sugar-beet pulp (up to 20 per cent. of the ration). These substitutes may be used more generously in the feeding of sows.

HINTS ON FEEDING

It is imperative, with a view to saving concentrates, to be sure of getting the full feeding value from available hay and oat straw. The hay allowance of dairy cows, for example, should not be a matter of guesswork. It pays beyond all doubt to cut out the hay in trusses weighing about 56 lb. Such a truss can then be used to supply 14 lb. per head to 4 cows, or 11 lb. per head to 5 cows and so on, according to plan.

When meadow hay of good average quality is available, cows yielding no more than 2 gal. of milk should be given little or no concentrated food. A full ration of such hay should suffice. When leguminous hay, such as lucerne hay, is to hand, the possible saving of oil cake in the milk-production mixture should be kept in mind, since 18 lb. of good lucerne hay not only supplies all the requirements for maintenance, but leaves over sufficient protein for the production of 3 gal. of milk. Foods such as roots, cereals, sliced potatoes and beet pulp can therefore be used, without oil cake additions, to produce (along with lucerne hay) the first 3 gal. of milk.

The feeding of kale to sheep and cattle enables a great saving of concentrates, particularly those rich in protein, to be effected. The dry substance in kale is equal in starch equivalent to that contained in swedes, but it is very much richer in protein and minerals. For example, a ration of 10 lb. of average meadow hay and 65 lb. of thousand-head kale would enable a lean store of 8 cwt. to fatten at the rate of 2 lb. per day. Similarly, a ration of 16 lb. of meadow hay, 60 lb. of thousand-head kale and $\frac{1}{2}$ lb. of crushed oats would suffice for the maintenance of a 10-cwt. dairy cow and the production of 2 gal. of milk. The kale should always be fed immediately after milking, and never before, to avoid risk of taint.

The old and traditional use of oats and beans for milk production points the way to independence of imported grains and seeds. When these are available, 4 lb. of a mixture of equal parts of crushed oats and bean meal will supply the nutrient for the production of a gallon of milk. Further, the inclusion of 2-3 lb. of crushed beans in the fattening rations of store beasts can enable oil cakes to be dispensed with altogether in such feeding.

An experiment just concluded by the writer and Dr. Evans at Cambridge shows that it is possible to get excellent results in the production of bacon pigs with much smaller proportions of fish meal, meat meal, bean meal, blood

HINTS ON FEEDING

meal and similar protein foods than are usually thought necessary. Using a ration containing barley meal and weatings, with 2 per cent. of lucerne meal and 2 per cent. of minerals, just as good results in rate of growth and carcass quality were obtained with baconers receiving 16 per cent. of bean meal and 2 per cent. of blood meal up to 90 lb. live weight, and no protein food whatsoever thereafter, as were obtained with pigs receiving 10 per cent. of fish meal up to 150 lb. live weight and 10 per cent. of bean meal from 150 lb. to slaughter at about 210 lb. On account of the small rations needed up to 90 lb., it will be realized that the amounts of bean meal and blood meal actually used in the feeding of the pigs on the low-protein dietary were not very considerable.

When only small supplies of concentrated foods are available, the pig-feeder might do well to fall back on the Lehmann system of feeding. The meal allowance should never be increased beyond that reached at 50-60 lb. live weight ($2\frac{1}{2}$ to 3 lb. of meal) and the pig should be allowed to satisfy its further appetite with such bulky foods as cooked potatoes, boiled roots, soaked beet pulp, boiled swill, or green foods such as kale, cabbage, sprout residues, etc. Growth will naturally be somewhat slower than on normal meal rations, but an appreciable saving of meal will be possible. When the bulky food is of a carbohydrate nature (e.g., potatoes and beet pulp), the basal food should be somewhat richer in protein food than usual, but this will not be necessary when it is of a protein-rich character (e.g., kale and other green foods). More authoritative information about this method of feeding will be available shortly.

Palm-kernel cake is likely to be procurable without much difficulty in the immediate future. This is an oil cake of moderate protein content (19 per cent.) Its balance is almost that of a milk-production mixture, so that it can be used, without admixture with cereals, at the rate of $3\frac{1}{2}$ lb. per gallon of milk. It is an excellent food for supplying protein in the rations of sheep and cattle. It may even be used for replacing fish meal in the rations of pigs, provided 2 per cent. of a mixture of 3 parts of ground chalk and 1 part of salt is added to the ration. The effect of the cake in pig-feeding is enhanced by the incorporation of a little blood meal. Any initial disinclination of stock to eat palm-kernel cake may readily be overcome by the addition of a little molasses, the use of which may be discontinued after a few days.

A PLEA FOR THE HORSE AND SIMPLE TACKLE

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How short a time it is since it was the ambition of the youth, embarking on a farming occupation, to be able to manage a pair of horses. He watched the skilled manipulation of the trained hand and in his turn reproduced, with careful imitation, the gestures, words and noises, to which for generations the horse had responded. What joy there was in grooming horses and cleaning harness till they outdid those of his rivals! The visit to the local smithy was a diversion not lightly to be missed. There was all the excitement, too, of the local ploughing match. The old order has changed with a vengeance. It has changed for many reasons—reasons which do not concern us here. The truth is we are now “tractor minded,” though I have yet to meet the real countryman who does not recall with pride the handling of a pair of horses. The tractor has come to stay, but in the present emergency, while we strive to increase the number of tractors and implements, there is no reason why we should not take our old friend the horse into our confidence and get on with the job. As an old hand might say: “He has done it before and he can do it again.”

On many farms, arable cropping has given way to grass farming, and though horses remain, neither implements nor men skilled in their use, are readily available. In order to do their bit in the ploughing campaign the natural impulse of farmers may be to buy or hire a tractor. On large farms, or where considerable areas have to be ploughed, the tractor is the implement for the job, but on small farms it may be advantageous to do the work with horses. Tractors and their implements are expensive for the small farmer to buy, and if one is to depend on hire one must await the convenience of the contractor. The advantage of being able to cultivate at the right time cannot be over-rated. There is no reason why in the present emergency some farmers should not carry on with horses and the minimum of equipment.

Corn Crops. Given horses and harness, a plough of some sort is essential and much can be said in favour of buying a new one. A one-way plough is a boon to a novice as

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feelings or cops and awkward finishes are eliminated. If a new plough cannot be purchased, a second-hand one might be found—perhaps at a farm where horses have been displaced by tractors. There must be many good ploughs lying about and it might be worth while to call in the assistance of some old hand to select a suitable tool. A cutting wheel or disc coulter will be an aid when ploughing old grass land. A skim coulter is also useful, but observation shows that some skill is necessary before it can be used efficiently on turf. The skim is more useful on stubble and a beginner should use it for this purpose. Ploughing can be regarded as the foundation of arable cultivation, and a farmer should take some care to see that it is well done. There are still a few old waggoners about the countryside, and if given a chance, they will set a plough and perhaps demonstrate how it should be worked.

A set of harrows will be required and they may be available on many grass farms. Possibly the harrows may have been put to uses not originally intended, such as filling a gap in the hedge or holding down a stack! Even a scrap heap has been known to reveal unexpected treasures. If an old set is found, it may be advisable to have the points laid or sharpened. The local blacksmith will be pleased to have the job. If the ploughing has been well done and in good season it will not be difficult to break the soil into a suitable tilth for the seed. It is usual to sow corn crops with a seed drill, but drills are costly implements. In place of this, the broadcast method (machine or hand) can be employed, though rather more seed will be required. An increase of 10-20 per cent. can be recommended. Some prefer broadcasting, and in parts of Scotland modern seed drills have gone out of favour. Small areas can be sown by hand. The seed should be broadcast on the plough furrow before it is harrowed, otherwise it may be difficult to cover. Sowing by hand is an art easily acquired by practice. The cast should carry the seed well forward and upwards. A simple method is to use a bucket and sow with one hand. A sowing sheet which allows the use of both hands is preferable and it is advisable to sow half the seed in the direction of the furrows and the other half at right angles. This will greatly reduce the chance of a miss. It may, however, be possible to borrow a seed drill, but it is not essential.

A flat roller will be required to level and compact the surface soil. A scythe is likely to be available, and will be

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needed at harvest time for opening out, and for cutting laid patches of corn. Perhaps a neighbour could lend a horse binder or he might even cut the crop. Failing this, it should be possible to hire from a contractor or from the War Executive Committee. Small farmers cannot be expected to purchase new implements such as seed drills and binders. Compared with tractors, horses move slowly, and time can be gained by stacking in the field. A dry site should be selected so that the threshing machine can be set to the stack. Carts or lorries, of any type, can be used for carrying the corn. Pitchers in the field prefer low vehicles, whereas waggoners, pitching to a stack, find high ones more convenient.

Potatoes and Root Crops. Land under roots provides more actual foodstuff than when under corn. Few implements are required and the small farmer with a pair of horses may find it advantageous to grow roots on part of his newly-ploughed land. If the area is very small, roots would be preferable to corn. In addition to the zig-zag harrows, a set of spring-tooth harrows would be useful, but a second-hand drag or cultivator will do the job. Heavy implements are a doubtful advantage. If the land has been well ploughed at the right time, it should be possible to work a tilth from the surface downwards without undue disturbance of the soil. I have seen potatoes grown on old turf where the only implements used were a plough and a horse hoe with ridging attachment. The field was ploughed alongside a straight fence and the furrows were cut 7-8 in. deep and 12-13 in. wide, so that two furrows would make a 24-26 in. drill. At planting time the horse hoe went up and down between every second furrow and this made a nice deep tilth. The ridging attachment was then fixed to the hoe, and by following the worked parts the field was ridged up and farmyard manure applied. The potatoes were set on the manure and covered lightly by the horse hoe. Another turn of the hoe made sufficient tilth to complete covering. Three months later, an excellent crop of Ninetyfold was dug up on this field. In the north, roots are grown on ridges, but a ridging plough is not essential. An ordinary plough with a sack tied round the breast will set up drills. Another method is to attach a shovel to the land side of the plough. It may be noted that in a dry time seed will germinate on ridges set up by an ordinary plough, while it may fail on ridges made by a double-boarded ridging plough.

A PLEA FOR THE HORSE AND SIMPLE TACKLE

Artificial manure can be sown by hand if necessary, but a turnip or mangold drill will be required for sowing roots. One can, however, sow a good flat of roots in an evening and it should be possible to borrow a drill for the purpose.

The small farmer will in time be compelled to make full use of his horses in the drive for increased food production. At first it may seem undesirable to purchase even small implements, but no one can foretell how long the war may last. Fields may require to be ploughed a number of times, they will become dirty under successive corn crops and cleaning operations will be necessary. Ultimately it may be desirable to reseed to grass, and with the knowledge now available it would be deplorable if fields should be allowed to tumble down as they did after the last war. It is obvious that the man who makes up his mind to purchase implements and make full use of his horses will in due course find that his outlay has been justified. Experience may prove that arable land is an asset on a small farm.

THE IMPORTANCE OF MOLE DRAINING IN PRESENT CIRCUMSTANCES

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Field Drainage and Food Production. The County War Agricultural Executive Committees are now devoting much thought and energy to increasing the arable acreage of the country. It is clear that the decrease which took place subsequent to 1918, and even in the years preceding the 1914-18 war was made up to a considerable extent of:—

- (a) land of the heavier types,
- (b) land in need of drainage.

These are the types of land, sown or tumbled down to grass, which will provide much of the increased acreage now required. Further, the productivity of a great deal of the existing arable land which comes in these categories is limited by inadequate field drainage. There is reliable evidence that 25 per cent. of the heavy land of the country is in distinct need of field drainage, and in many parts of the eastern counties considerable areas are derelict for this reason. This condition can be largely rectified by means of the mole plough.

Where Drainage is Most Urgent. Grass land, in proportion to the age of the ley and its quality, will, on ploughing-out, produce a tilth condition which in itself is better for drainage than that obtainable on similar soil after a spell of arable farming. For one winter or even two, such land, therefore, might overcome the drawback of poor field drainage, especially if the winters were not excessively wet. In fact, on any given farm, the treatment of existing arable land with poor field drainage is the more urgent.

This argument, however, does not hold for heavy land of derelict or semi-derelict type, where the grass is the result of tumbling down. On such land, productivity in terms of the so-called grass is obviously low, bare space is considerable, and it follows that root action and development, with all that these imply in tilth or structure effects, are at a minimum. For these, field drainage is essential for successful reclamation, but as such land will not be cropped for the 1940 harvest,

THE IMPORTANCE OF MOLE DRAINING

its drainage is not as urgent as that of existing arable land. The remaining grass land, too, should not be neglected, especially on heavy soils. Its productivity can be increased by mole draining where it is necessary. The herbage is improved, growth begins earlier in the spring and the periods during which fields must be shut up for fear of poaching are shortened.

The Cost of Field Drainage. The land most in need of draining to-day is, unfortunately, least able to bear costs of any kind. Most thorough draining has been carried out by means of tiles and the operation has been regarded as a permanent improvement. Tile draining is laborious and costly—£10-20 per acre before the commencement of the war. For most heavy land, the costs of such work are prohibitive, yet instances are not lacking within the past two years of heavy land being tile drained at as little as £10 per acre.

Mole draining provides a cheap and highly effective alternative. Drainage in general has for so long been regarded as an expensive operation, which in terms of tile drainage it is, that it is not always realized that mole draining is a comparatively cheap tillage. It can be carried out and finished off with tiled mains and outfalls for 50s. or less per acre. Such a system will function well for 7 years or more, and can be renewed simply by re-drawing the moles at 14s. per acre.

In point of fact, good mole draining is, and should be, viewed as an important heavy land cultivation. It compares favourably with other such cultivations and is altogether more desirable and more important. Contractors' charges for gyrotilling were recently quoted as 33-40s. per acre, for sub-soiling 25-30s. per acre. Heavy mole draining by steam tackle at 20-25s. per acre compares favourably with these. Fleeter work by heavy tractor at 14s. or by the farmer's light tackle at half this amount or even less, ceases to appear so costly.

The Cost of Mole Draining. The cost of mole draining depends on:—

- (i) The type of machine employed.
- (ii) The calibre, depth and distance of the mole channels.
- (iii) The kind of main and outfalls.
- (iv) The labour, tiles and other materials used.

THE IMPORTANCE OF MOLE DRAINING

Taking a particular example, the moles were drawn by a caterpillar tractor using a 3-in. plug, at a depth of 24 in. and distance 3 yd., pulling uphill only. The work was finished off with tiled mains and outfalls with gratings, the mains being bushed in. There were 1.4 chains of main per acre. The actual costs were, per acre:—

				<i>s.</i>	<i>d.</i>
Drawing moles	..	..	..	15	0
Digging mains, laying, bushing,	..	..	..	15	4
carting, filling	..	..	..	18	8
Tiles, pipes, gratings	..	..	..	49	0
TOTAL				..	0

Actually, in this instance, the finishing was careful and thorough, and the length of mains was greater than usual (1.1 chains per acre is an average figure).

Quite two-thirds of the cost is involved in the main, but all the items in the work vary greatly with circumstances. Steam-tackle contractors will draw a 3.5-in. plug at depth 27 in. and distance 4 yd. for 20-25s. per acre, while a farmer might draw a 2-in. plug at depth 14 in. and distance 3 yd. for as little as 6s. per acre, using a wheeled tractor.

Possible Economies in Mole Draining. In present circumstances, it is desirable to seek economies both in labour and material, as far as possible without sacrificing too much in efficiency of the resulting system of drains. On the assumption that all weights and types of tackle will be utilized as fully as possible, economies must be sought in the operation itself.

DISTANCE. Widening the intervals between adjacent channels is an obvious possible economy, but there is as yet no definite evidence of how far this can be done without serious loss of efficiency. The cultivation, heaving or bursting effect of the passage of a mole plough is obvious to the eye. For a heavy plough it can be put at 2-3 ft. on either side. The benefit derived from the moles in keeping the top soil free from excessive waterlogging may reasonably be expected to extend farther than this, so that a 9-12 ft. interval looks theoretically sound on the heaviest clays. There is reason to hesitate before increasing this interval farther, unless a very substantial saving can thus be effected.

In thorough draining it is a general rule that drain distance

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should be increased with increasing permeability of the soil, but this argument should not be applied to mole draining on the heavier range of heavy clays, clays, and clay loams, as an increase in permeability is accompanied by a decrease in the stability of the mole channels, i.e., they collapse more quickly, and on that account it might be argued that they should be closer together initially.

Taking a figure of 14s. per acre for mole draining at 3 yd. distance, the possible effect of increasing the distance is as follows:—

<i>Distance</i>		<i>Chains of Mole Drain per Acre</i>		<i>Cost per Acre</i>
				<i>s. d.</i>
3 yards	..	73	..	14 0
4 „	..	55	..	10 8
5 „	..	44	..	8 7

In contract work, it is found that increasing the distance from 3 to 5 yd. is accompanied by a decrease in the price of from 3-5s. per acre.

BUSHING OF MAINS. It is difficult to assess the cost of this excellent practice, as it depends so greatly on farm circumstances and farm routine. Its omission would result in a definite economy of effort and labour rather than of cash expenditure.

TYPE OF MAIN. By far the greater part of the cost of mole drainage is accounted for by the mains and outfalls, and there is a natural desire to reduce expenditure under this heading. This can be, and frequently is done, particularly where heavy tackle is employed. Before drawing the minors, two or three mole channels are drawn, larger and a few inches deeper than these, in the appropriate place for the main; and leads from these moled mains to the outfalls are dug and tiled in the usual way. By this procedure the expenditure on mains can be reduced to 3-4s. per acre, a really substantial economy. Against this must be set the risk of the moled mains collapsing after two or three years' service, though in war time this is not a serious consideration.

MOLING DIRECT FROM DITCH. This method is occasionally possible and is attractive as enabling the whole job to be done mechanically and making it possible to avoid all expenditure on mains. In the field there are many difficulties to be overcome. The fall of the land is often not continuous to the ditch owing to the accumulation of a spoil bank from its cleaning and maintenance. The soil near the ditch is often

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more loamy, and the stiff clay is at a greater depth than the mole channels, so that these soon collapse. There is frequently a hedge or fence which makes the ditch inaccessible to the mole plough. The practice entails much damage to the ditch and the tackle is limited to drawing one way only. These difficulties can be overcome by digging an entry from the ditch for the mole plough, by tying the mole channels in groups of about 4-6 by making one cross the ditch ends of the others to serve as a main, and by tiling 2-3 ft. of each outfall, but the labour and material involved, and the slowing down of the work, render the idea unattractive.

The Best Season for Mole Draining. The planning of mole draining should take into consideration the suitability of soil conditions at different seasons. In general, the effect of summer is to dry out heavy land to such an extent that suitable mole draining conditions rarely occur before October. After a moist summer they may be found early in September; with low summer and autumn rainfall, however, they may be delayed into November or even later. The middle of winter generally finds the surface conditions too wet and sticky for the machines, but the onset of spring removes this drawback, and the subsoil is in its best state for taking the mole. March, April and May are most favoured for mole draining, but October and February also can be relied on to provide suitable conditions in most seasons. On the whole, there are fewer opportunities in autumn than in spring, as far as the best soil conditions are concerned, so that there is room for discrimination in their utilization. In this connexion, too, it is useful to note that mole draining can be carried out without an undue amount of damage to a young standing corn crop.

Mole Draining Outfits. There is a great variety of tackle available for mole draining, e.g., the ordinary wheeled tractor drawing a light mole plough, the heavy track-laying tractor with a heavy mole plough, the two-engined steam or Diesel cable sets with very heavy mole ploughs.

Light mole ploughs can give their best service on grass land, in which shallow mole channels, at 12-18 in. depth, drawn two or three to a furrow 3-4 ft. apart if the field is in high-backed lands, or 6-9 ft. apart if it is not ridged, will produce the desired result.

While a mole plough can be operated with a tractor and

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one man, cable sets need four men for their operation, and steamers need coal and water to be carried in addition. In present circumstances, however, it may be necessary to use all available tackle to the full, and the natural home of the cable sets in heavy land districts is where much of the extra acreage required will be found. The Steam Cultivation Development Association has listed its resources in this connexion. Amongst its members there are in England about 100 sets in use or ready for use and about 50 sets capable of being easily reconditioned and put into service once more. Not all steam-tackle owners are members of the Association, and it is estimated that there are in the country at least 250 sets in use or potentially available. Although these machines need more labour to work them, they don't need oil fuel and they are still recognized as being eminently suited for mole draining heavy clay land.

NOTE. In the course of a speech in the House of Commons on December 14, the Minister of Agriculture intimated that the Government proposed to take further steps to secure the better draining of land in England and Wales which is potentially fertile but which is at present waterlogged. Among other proposals in connexion with land drainage, legislation will be promoted enabling the Government to make grants of 50 per cent. (subject to a maximum grant of £1 per acre) of the cost of approved schemes of mole drainage for a period of one year. Further particulars of the manner in which application should be made for such grants will be announced at an early date.

THE HEALTH OF SEED POTATOES

Degeneration Due to Virus Diseases is the Greatest Source of Loss

An increase in the acreage planted with potatoes during war time, together with the need for maximum yields, should mean a considerable increase in the demand for good quality seed. There is no agricultural crop in which the *quality* of the seed counts for so much as it does with the potato. Not only is the yield lower from seed that is infected with virus diseases, often by several tons to the acre, but a proportion of the money spent on cultivation and manuring may also be regarded as largely wasted, for no stimulus will make badly infected plants respond with a good crop.

Unless care is exercised, one result of an increased demand for seed might be a general deterioration of stocks. Such a deterioration actually took place at the time of the last war, but during the intervening years a great deal has been learnt about the causes of potato degeneration, and a repetition of that state of affairs is now less likely. The problem, however, involves a continuous and heavy drain on the seed-producing districts. Anything, therefore, which the grower in the ware districts could do towards maintaining the cropping power of his new seed would make a contribution of value towards the production of maximum yields.

Degeneration and its Causes. Before considering what steps could be taken in this direction, a very brief outline may be given of present knowledge on the subject of degeneration from the practical side. Each year more than 100,000 tons of seed potatoes are imported into England from Scotland, Northern Ireland and Eire. In some districts this seed is grown once only, as experience has shown that it pays to get fresh seed every year. Such districts, in which the spread of potato virus diseases is very rapid, are fortunately very limited in extent. Over most of the country the seed-size tubers of crops grown from Scotch or Irish seed are grown again at least once and often twice before the stock has to be discarded. In certain parts of the north of England

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it is possible to grow crops three, four, or even more times from fresh Scotch seed.

At the end of the last war, the real cause of the degeneration of potato stocks was known to comparatively few. Now, however, it is fairly widely recognized that degeneration is due to the rapid increase within the stocks of certain virus diseases, the more important of these being spread from plant to plant by means of aphides or green-fly.*

Potato stocks remain healthiest in districts where there is much wind during the growing season and where the climate is cool and moist, and it is usually a rare thing to find more than an odd aphid or two on potato plants growing under such conditions. Stocks degenerate most rapidly, on the other hand, in districts where the climate is warm and dry, and where there are long periods with an absence of wind in summer. Conditions such as these are favourable for the multiplication and dispersal of green fly, which, in the process of feeding, soon transmit virus from any diseased plants in the neighbourhood to many of the surrounding healthy plants. This, then, is the reason that potatoes in the farthest north are healthiest, and that as one moves southward into warmer climates where green fly are more abundant, the potatoes succumb more rapidly to disease. There is no infallible magic in the name of Scotland as far as seed potatoes are concerned. In sheltered and warm situations the virus diseases of potatoes can spread almost as quickly in Scotland as in England. And on the other hand, in the bleak, upland districts of Cumberland and Wales, or, as has recently been demonstrated, on the Devon and Cornish moors, potatoes remain healthy as well as they do in Scotland. It is all a matter of whether or not the conditions are suitable for the multiplication and spread of green fly, and Scotland and Ireland are fortunate in having larger areas than England that are suitable for potatoes but unfavourable for the aphid transmitters of disease.

Increasing the Supply of Good Seed. It will be seen from the above that there are two directions in which maximum yield must be sought, namely (1) in an increase in the amount

* The three potato virus diseases of most economic importance in England are Leaf-roll and Leaf-drop Streak (Virus Y), both spread by means of aphides, and Mosaic, spread by leaf-contact. These diseases are more fully described in Advisory Leaflets Nos. 278 (Leaf-roll) and 139.

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of good quality seed produced in districts suitable for seed production, and (2) in doing as much as is practicable towards minimizing the rate of degeneration of good seed when it reaches the ware districts.

It is obvious that an increase in the supply of good seed must come mainly from Scotland and Ireland, which have the largest areas with conditions unsuitable for the spread of green fly. It is likely, however, that in time of war the similar but smaller areas in England and Wales will also need to be more fully exploited than in normal times.

Growers in all these areas can contribute in two ways towards increasing the supplies of good quality seed. In the first place, the best stocks available should be procured for multiplication. If the grower's own stocks do not reach the standard for a TS(A) certificate he should consider the purchase and multiplication of such a stock elsewhere. It is only by retaining the best stocks in the best districts that the supply of good seed throughout the country can be increased. In the past, some of the highest quality seed has been spoilt in one year and been lost for ever by being sent to be grown in a bad district, whereas if it had been retained in a seed-producing area it would have raised the standard of seed and exercised a good effect over a long period. In the second place, all growers in the seed-producing districts should rogue their crops for disease as well as for trueness to type. It is from the diseased plants that all the trouble spreads, and the point of greatest importance in maintaining the health of a stock is early and frequent roguing out of all diseased plants. It is obvious that the better the stock that is being multiplied the less roguing will have to be done. It should be the aim of all growers in the seed-producing districts to purchase only stocks with Stock Seed or TS(A) certificates, and to keep them up to the standards for these certificates by careful roguing.

Minimizing Degeneration in Ware Districts. How much can be done towards minimizing the rate of degeneration of stocks when they are brought down to the ware districts has never been properly investigated in England. At present new Scotch or Irish seed is very frequently planted in the same field as once- or even twice-grown English seed, in order to facilitate the farm rotation. This gives every chance for virus diseases present in the English seed to be carried across to

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the Scotch or Irish, and naturally hastens the rate of degeneration and the decline in yield of the latter.

Bryan has shown that it is possible to maintain the health of a good stock in the Ormskirk district of Lancashire for at least six years by isolating a portion for seed purposes in an oat crop and roguing it thoroughly. It is not possible to isolate very much seed by growing it in the middle of corn crops, however, and more investigations are needed in various districts on the benefits to be derived from an isolation of a hundred yards or even less, with or without roguing, but with no other disturbance of the farm routine.

A little special attention to crops from which seed is to be saved should be amply repaid by larger yields the following year. The measures recommended are (1) the growing of new Scotch or Irish seed separated as far as practicable, and by at least 50 yd., from any once- or twice-grown seed. Experience has shown that it is also advisable to have it separated from any Brassica crops (cabbage, kale, etc.), on which green fly may over-winter and multiply rapidly in spring. (2) The roguing out of diseased plants to prevent the spread of disease to neighbouring plants. An article on roguing will appear early next season. (3) Destruction of the haulm, soon after the plants have reached the peak of their growth, with sulphuric acid, or, in small crops, by cutting. This prevents much late infection of the tubers with virus diseases and may also prevent infection of the tubers with potato blight. This measure may entail a slight reduction in yield in the year it is done, but it should be more than repaid by an increased yield from the seed the following year. The same effect may be attained by early lifting of a portion of the crop, yielding the so-called "immature" seed, but more careful handling of the seed is then required.

The effectiveness of these recommendations will naturally be greatest in northern districts. If growers in Yorkshire and Lincolnshire would take a little extra trouble with their best crops they might considerably increase their sales of seed potatoes to other parts of England. In some of the southern districts there is often too much virus disease reaching the crops from outside sources to warrant expenditure on roguing.

There are two other points of first importance that should be mentioned when considering the maintenance of health of seed stocks. Where seed is chitted, proper fumigation of the

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chitting houses should be carried out during the winter, usually by vaporizing nicotine, to prevent aphides spreading virus diseases from sprout to sprout in the chitting boxes. And when a field is planted with new Scotch seed which does not quite fill the field, it is the worst thing that can be done to complete the sowing with "any old bit" of once-grown seed, or even to fill in an old grave or clamp-site with such poor seed. The few hundredweights of extra crop obtained in these ways may be paid for by a loss of tons the following year, when the seed saved from the Scotch crop is planted. All old seed may be regarded as "infectious," and should be kept well away from new. It would be preferable to keep old clamp sites quite bare rather than to plant them with poor seed, or allow diseased ground keepers to grow on them and be a source of infection for both blight and virus diseases to a neighbouring healthy crop.

At a time when maximum yields are required of all potato growers, every care given to maintaining the health and cropping power of seed stocks should be of value. All that can be done at the present time, however, is to plan for planting the season's new Scotch or Irish seed in isolation.

Finally, one other measure worth consideration in the heavier rainfall districts in the west is the planting of cut ware potatoes obtained from seed-producing districts. As far as freedom from virus diseases is concerned, the ware-size tubers are as healthy or more so than the seed-size. Cut ware will often not succeed in the drier districts, however, nor is cutting advisable for some varieties, such as Majestic and Ally.

In the above article it has been possible to consider only one aspect of the health of seed potatoes, namely, that concerned with virus diseases. Questions such as the dipping of the seed of early varieties, at the time of digging, in formalin or organic mercurial disinfectants, to prevent dry rot or blight, the proper storing and chitting of seed potatoes, prevention of frost injury, etc., have all an important bearing on the production of healthy seed, but these subjects must be left for discussion on another occasion.

Summary. If maximum production from the area planted with potatoes is to be attained, the following measures to maintain the health and cropping power of potato stocks should be adopted as far as practicable. These measures are recommended only for crops from which seed is to be saved

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for the following year, as it is on the quality of the seed that the yield so greatly depends.

A. IN ESTABLISHED SEED PRODUCING DISTRICTS, in Scotland and Ireland, and in the smaller districts suitable for seed-production in Wales and in England (e.g., Cumberland or the Devon and Cornish moors) :

1. The planting of high quality (SS or TS(A)) stocks as far as practicable by all seed growers.
2. The roguing out of diseased plants by all seed growers.

B. IN WARE-PRODUCING DISTRICTS :

1. Isolation of new Scotch and Irish seed as far as practicable by growing it in a field separated by 50 yards or more from once-grown potatoes or from over-wintered Brassica crops (cabbage, kale, etc.).
2. The roguing out of diseased plants from such crops.
3. Destruction of the haulm after maturity with sulphuric acid (or by cutting). This may prevent much late infection with virus diseases as well as save the tubers from potato blight.
4. Fumigation of chitting houses.

LINSEED AS A HOME-GROWN CROP*

Linseed is grown both for its seed, which is a valuable source of oil, the residue forming oilcake, and for its flax fibre, the raw material of the linen industry. The present article is concerned solely with the seed aspect. Linseed has long been esteemed as a food of special value for farm animals, particularly for dairy cows, fattening bullocks and calves. Its value in this connexion rests in its high content of oil, about 35-37 per cent., and protein, 24 per cent. The main supplies arrive in this country after long sea passages from India and the Argentine, but as the crop is suited to the British climate and to many of the British soils, much more of it might be grown at home and thus help to ensure supplies of this very valuable feeding stuff.

Soil. Any good medium soil is suitable. Provided the land is clean, its selection is of less importance than its proper preparation before sowing the seed. As the crop is unable to withstand drought, sandy soils are useless, and on heavy clays it is difficult to prepare the necessary fine seedbed. Land that is clean and well adapted for barley, or a medium loam with a stiff sub-soil—a good wheat bottom—are excellent. Some good crops have been grown on poor chalky land after using a complete fertilizer.

Neither wireworms nor leather jackets attack linseed, and it is therefore worthy of consideration as a crop on newly ploughed-up grass. Rabbits generally leave it alone. Wheat does well after linseed, and it does well after wheat. It is usual, in fact, to grow it after a straw crop of some kind. Where the soil is inclined to be light, however, it is advisable to take linseed after a root or green crop that has been fed off by sheep. It is a good nurse crop for clover or seeds. The clover benefits by the shade given by the linseed and the weeds are checked.

Cultivation. Linseed is a rapid grower, and it is the aim of cultivation to provide conditions for this growth to be even and continuous during the ten weeks or so that the crop is growing. The land should be deeply ploughed in autumn or early winter, and left to weather until near the time of sowing, for which a fine seedbed with a firm bottom should be prepared.

Manuring. A high state of fertility is not necessary, and

* This article is reprinted as "Growmore" Leaflet No. 13, single copies of which are obtainable free from the Ministry.

LINSEED AS A HOME-GROWN CROP

the crop does best when using the reserves of fertility left from a previous well-manured crop. Unless the soil is very poor, the application of nitrogenous artificial fertilizers does not bring about any marked increase in the yield of seed or in the oil content of the seed. Potash and phosphates help towards early ripening; these are best applied, to soils that require them, as a dressing of 3 cwt. superphosphate and 2-3 cwt. potash salts per acre.

Sowing. For seed production, the best variety is *La Plata* or Plate linseed, although Canadian, North African and Russian seed have given good results. Bombay seed produces a short straw and is therefore sometimes difficult to harvest. Dutch White-flowering is hardy and ripens late. Apart from the question of source, the sample should consist of plump, well-developed seeds of good colour. Care should be taken when using imported seed either to dress it thoroughly or to ensure that this has been done by the seedsman, otherwise there is a danger of introducing foreign weeds on to the farm. Seed should be kept in a cool, dry place, as it readily absorbs moisture and thereby loses its vitality.

Seed should be sown as soon as the danger of severe frosts has passed, and as soon as a fine tilth can be prepared. A moderate frost can be tolerated, but drought in the early stages is a serious drawback. On the lighter lands, and in the south, sowing may begin as early as the end of March, but on heavy land, and in the north, it may not be possible until May.

An expert sower may be able to broadcast this slippery seed, but more usually sowing is done with a "fiddle," a seed barrow or a special drill with narrow spouts. If a light corn drill is used—not all, however, can sow thinly enough—the coulters should be set about 6 in. apart. The seed should not be deeply buried— $\frac{1}{2}$ in. to 1 in. deep is desirable. If broadcast, $2\frac{1}{4}$ bushels (117 lb.) of seed will be required per acre, but this may be reduced to $1\frac{3}{4}$ bushels (91 lb.) for the other methods of sowing. A heavy crop has been obtained on poor land with $1\frac{1}{4}$ bushels assisted by a complete fertilizer. If grass seeds are to be sown, they should be put in at the same time as the linseed.

A light harrowing, followed by a light rolling is all that is necessary after sowing.

Weeding. Linseed does not smother weeds as effectively as other straw crops, and consequently the land should be clean to start with.

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Harvesting. Flax seed ripens somewhat unevenly, but as it will mature in the stook it is cut when the earliest bolls are ready, which is usually when the stems have turned yellow and the lower leaves have fallen. At this stage, the seed in the oldest bolls are bright, plump and uniformly pale-brown in colour. If left too long, the crop loses much by shedding. It may be cut by hand, or with the reaper or binder, provided the knives are kept very sharp. Small sheaves are made and these are carted as soon as dry. It is possible to set up the heaps of loose linseed like stooks, for the plants mat together.

Yield. A crop of 20 cwt. per acre has been grown in this country, but the average is about 10 cwt., with rather less chaff. The straw amounts to 20-30 cwt. per acre.

Threshing. The ordinary threshing drum is used with the finest riddles, and with the concave drum set very close.

Straw and Chaff. The straw is unsuitable for feeding; it makes a good bottom for a stack or bullock yard, but is too wiry and slow in rotting for ordinary litter. As thatch, it is useful for covering clamps, lasting much longer than either wheat or rye straw.

The chaff consists largely of broken seed capsules, and may be used in the making of linseed jelly, as described below, or it may be fed to stock in the same way as other grain chaff. Ewes are very fond of it, and it was once very popular for sheep on roots, but high fibre content of linseed makes it unsuitable for very young stock, especially lambs.

Grinding. The ordinary grist mill with steel rollers, or the oat bruiser may be used, but some difficulty occasionally arises in mills using stones, through the mill clogging owing to the large amount of oil that is pressed out. Some absorbent material must be added. Chaff, oat husks or previously crushed grain may be used.

Use in Stock Feeding. As the various forms in which linseed is used for animal feeding have widely different values, it may help to avoid confusion if these are shortly described. Linseed meal is whole linseed ground up to a meal without the subtraction of any of its oil. Linseed cake is the compressed residue after a large part of the oil has been pressed out from the crushed seed. Extracted linseed cake or meal is the meal remaining after most of the oil has been extracted by solvents, and contains only about 3 per cent. of oil.

The following notes deal exclusively with the complete original seed, either crushed or boiled, and without the

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removal of oil or husk. Although occasionally done, it is wasteful to feed untreated linseed, as a considerable portion of the seeds usually passes through undigested by the animal. Linseed, once known as the sheet anchor of the stock feeder, is still largely used for animals that are being "finished off," and for imparting a healthy "bloom" or gloss to the coat.

A very rich food, linseed is somewhat laxative, although it has a soothing effect on the bowels that makes it especially useful for sick animals.

Linseed should never be used with only a mere preliminary soaking in cool or luke-warm liquor. If moistened at all, it should be boiled or steamed to avoid the risk of fermentation producing dangerous substances, which has occasionally happened when this precaution has not been taken.

Linseed jelly is made by stirring the crushed seed into boiling water (10 lb. seed to 20 gal. water), then adding a little cold water, bringing to the boil again and allowing the mixture to remain boiling for about 20 minutes.

This jelly can be incorporated with chaff, hay, bran, potatoes, straw, damaged grain, green stuff or other similar material.

A firmer jelly or a form of meal can be made by stirring bruised oats, rolled wheat, chaff, etc., into the liquor while boiling the seed.

Linseed chaff may also be boiled along with the seed, or the crushed bolls may be used without any separation, but if this is done the crushing must be sufficient to bruise the actual seed.

Linseed is particularly valuable in the feeding of calves, when added to separated or skimmed milk as a substitute for the cream that has been removed. It may be used as boiled whole linseed or as meal in the form of a porridge. For the boiled linseed, 2 lb. of the uncrushed seed are soaked overnight in 3 gal. of water, boiled and stirred the next day for 20 minutes, and 5 minutes before the boiling is finished, $\frac{1}{2}$ lb. of flour (previously mixed with water to avoid lumpiness) is added to counteract the laxative tendency of the linseed. This keeps sweet for several days. It is used at the rate of 1 pint added to 2 quarts of separated milk.

For the thicker porridge, 1 quart of ground linseed is scalded and stirred with 1 gal. of boiling water. This is used at the rate of 1 pint of the porridge to 4 pints of separated milk for a calf 4-5 weeks old.

MISCELLANEA

The Lehmann System of Pig Feeding

The drive during recent years in Germany that had as its aim the realization of economic self-sufficiency has directed serious attention towards the pig as a consumer of large quantities of cereals, for supplies of which in times of scarcity it would come into competition with human beings and dairy cattle—a competition in which in the long run the pig would be worsted. Numerous investigations have therefore been undertaken on the Continent to discover to what extent the cereal contents of pig rations might be reduced, without undue loss of efficiency, in the production of bacon and pork.

The position of the pig industry in any country dependent to any appreciable degree on imported feeding stuffs is obviously a risky one in time of war, and the value of a system of feeding that will secure the maintenance and productivity of the pig population mainly on food materials produced at home is indisputable. The system devised by Lehmann in Germany has accordingly attracted much attention in countries beyond that of its origin.

Under this method in its original form, each fattening pig is allowed 1 kilogramme (2.2 lb.) daily of a basal ration comprising 70 per cent. cereal meals (barley, wheat, maize, wheat-feed, etc.) and 30 per cent. protein-rich concentrates (fish meal, meat meal, soya-bean meal, etc.) plus potatoes fed to appetite. Feeding with potatoes does not begin, however, until the pigs are big enough—some 50-60 lb. live weight—to consume at least 2.2 lb. of the basal ration per day.

In practice, the original system became considerably modified, and the potato portion of the Lehmann ration was frequently replaced in part by sugar-beet, sugar-beet by-products, mangolds, rape, etc., depending upon local supply conditions. According to data that became available, the cereal requirements could be reduced by one half under this system. For example, if an all-meal ration of cereals and protein supplements were used, and $5\frac{1}{2}$ cwt. of cereals, including wheat feed, were required from weaning to bacon weight, it should be possible on the Lehmann system to reduce the amount of cereals to about $2\frac{1}{2}$ cwt.

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It was decided last autumn by the Pig Experiments Coordinating Committee to carry out a series of trials at centres in Great Britain on this system of pig feeding, and the report has now been issued. The conclusions are summarized below, but readers requiring fuller details, including actual weights of all materials fed, may obtain a copy of the report on application to the Ministry.

As far as possible, a uniform system of experiment was followed, but the supplementary home-grown foods varied at each centre. The pigs used were Large Whites, or Essex × Large Whites, and were put on to the experiments at live weights between 40 and 60 lb. At each centre some pigs were killed at 200 lb. live weight, and others were kept on to 250 lb. Full carcass records were obtained for nearly all the pigs slaughtered.

From a live weight of approximately 50 lb., pigs on the "Lehmann" rations received $2\frac{1}{2}$ lb. per head per day of a basal meal ration, and this fixed quantity of meal was fed throughout the fattening period and never exceeded. The rest of the ration was made up of the supplemental foods fed to appetite. To allow some adjustment of the amount of protein fed in the basal ration, two mixtures were made up as follows:—

I	II
(CEREAL MIXTURE)	(TYPICAL LEHMANN FORMULA)
Wheatings .. 40 per cent	Wheatings .. 35 per cent.
Barley Meal .. 40 "	Barley Meal . 30 "
Maize Meal . 20 "	White-fish Meal 20 "
	Ext. Soya-bean Meal 10 "
	Lucerne Meal .. 5 "

At a live weight of 50 lb., the ration was to consist of 1 lb. of I plus $1\frac{1}{2}$ lb. of II. Thereafter, the proportions were to be altered in accordance with the nature of the supplements. With those low in protein, such as potatoes, $2\frac{1}{2}$ lb. of II would be used; with green foods, the rations of 1 lb. of I and $1\frac{1}{2}$ lb. of II would be maintained, and alterations would be made if warranted by the condition of the pigs, but in no circumstances would more than $2\frac{1}{2}$ lb. of the basal feed be given.

The supplemental foods included potatoes (steamed or boiled), swedes, mangolds, kale, cabbage, sugar-beet-top silage and fresh lucerne. All were fed to appetite. No difficulty was experienced in feeding these foods, and with few

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exceptions the pigs remained in good health throughout the experiments. Naturally, such bulky foods must be introduced gradually into the pig's diet in order to avoid digestive disturbances resulting in poor growth.

At the Cumberland centre, where potatoes, swedes and mangolds were used, meal consumption over the fattening period was reduced by nearly 230 lb. per pig, but about six weeks longer were taken to reach slaughter weight.

Cabbage, kale and potatoes were used at Durham. Here meal consumption was reduced by about 300 lb. per pig, and the pigs were fattened as quickly as those fed in the usual way.

Meal consumption was reduced by some 260 lb. per pig in Hertfordshire, using potatoes and sugar-beet pulp as supplements. The fattening period was lengthened by about one month.

In the Lincolnshire experiments, potatoes, waste cabbage, sugar-beet tops silage and fresh lucerne were fed as the supplements. Meal feeding was reduced by about 330 lb. per pig on the potato ration, and by about 170 lb. per pig on the green supplements. The pigs receiving potatoes made better growth than those on the normal meal ration. Those on the green supplements took about six weeks longer to fatten, chiefly due to slow growth on the silage.

Throughout the experiments, the feeding on this "Lehmann" method had little effect on carcass quality though, with the slower growth, a bigger-framed pig tended to be obtained.

Conclusions. This series of experiments has shown that by feeding a fixed, limited quantity of meal per day, supplemented by bulky foods fed to appetite, it is possible to reduce very considerably the amount of meal required to produce a bacon pig, up to 50 per cent. of the ration, or even more, being replaceable by home-grown greenstuffs or potatoes.

Apart from the home-grown products used in these trials, others are likely to prove equally valuable as supplements, such as market-garden refuse of broccoli, sprouts, and other brassica crops, green pea haulms, seeds aftermaths, etc., and trials of these are now in progress.

The time taken to reach a live weight of 200 lb. is liable under the system to be extended by 4-6 weeks, although the results show that in some instances it may be no longer than usual.

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The heavier classes of pigs are likely to use the bulky kinds of food to the best advantage.

Further trials are being conducted on a wider basis, and are being extended to investigate the results of this system of feeding on breeding stock. In the meantime, however, it is clearly evident that a much greater use can be made of roots and green stuffs, and that big economies can be made in barley and other cereal meals. In present circumstances this is obviously desirable. Were meal available, there would, of course, be no necessity to limit consumption to the extent that was done in these experiments, which do indicate, however, the great reductions in meal consumption that are completely successful in practice.

Top Dressing Wheat in Spring

Even in peace time, it does not pay to grow a poor crop of wheat. To increase the war-time output of home-grown wheat to the extent desired, it will be necessary not only to enlarge the acreage by ploughing up grass, but also to make sure of the heaviest possible yields on the permanent arable land.

Scope for Improvement. Trials recently made on farms representing average conditions have shown that a small dressing of nitrogenous fertilizer applied to wheat *at the right time* in spring brings an increase in yield of 2-4½ bushels an acre. But probably a fifth of our wheat crop is grown under poorer conditions than prevailed in these trials, and on many fields, therefore, the possible degree of improvement is even greater. Some experienced observers are convinced that there are a quarter of a million acres of wheat in Britain on which an intelligent use of spring top-dressings would, in years of reasonably favourable weather, increase the yield by 4 bushels an acre.

Nitrogenous fertilizers in spring are specially valuable on land in poor heart (it may be through inadequate manuring or growing too much corn), on crops badly set back by wire-worm or wheat bulb-fly, or where very heavy winter rains have checked growth. When good pasture is ploughed up, it will give a heavy crop of wheat without manuring. But much grass that has been under-grazed or cut too frequently for hay is likely now to come under the plough for wheat. Land of this type may need help in spring.

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A Common Error. The characteristic yellow appearance and slow growth of "nitrogen-starved" wheat at the end of winter are well known to farmers, many of whom make a practice of top dressing in late winter or spring. All too frequently, however, the application is made at the wrong time and therefore largely wasted. Put on at any time from Christmas to the end of April, a nitrogenous fertilizer will bring about the familiar healthy-looking change in colour of the young wheat, but it is a mistake to suppose that this improved colour will necessarily be followed by increased return at harvest. Success depends on using the right amount of fertilizer and, still more, on getting it on at the right time.

The effect of quick-acting nitrogenous fertilizers on the wheat plant varies with the time of year. Very early applications increase the number of tillers, while late ones increase the size of the ear. Extra tillers do not result in extra ears at harvest unless they are formed very early (roughly by mid-January). Of all the tillers found on a wheat plant in May, about 8 in every 10 always die off and, though outstanding plants can be found in every field, the majority come to harvest with only 1 or 2 ears apiece. To put on nitrogenous fertilizers in February or in the first three weeks of March—a not uncommon practice—may cause extra tillers to form, but most of these will die by the end of June. It may also lead to excessively long straw and thus involve the risk of lodging. Nitrogen applied in late spring is used up in enlarging the ears, for onwards from May no new tillers form and length of straw is not affected.

Correct Time and Amount. These facts about the growth habits of wheat clearly show how nitrogenous top dressings should be used. Normally, the best time is from the middle of April to the middle of May. Applications made after this will not increase yield and may delay ripening. There are, however, instances in which wheat comes out of the winter badly, having perhaps lain water-logged for several weeks. Here a little nitrogenous fertilizer in early March may be valuable to re-start growth, but even then the main part of the application should be reserved till after the middle of April.

Excess of nitrogen for corn crops delays ripening and may cause lodging. Strong pieces, for instance, on land in really good heart or following well managed, heavily-grazed pasture,

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would, naturally, not be top-dressed. Wheat put in early on highly-fertile soil may be too forward by early March. On a farm with a ewe-flock it offers some useful keep.

The best dressing is 1-2 cwt. an acre, according to the known condition of the land and the appearance of the crop.

Suitable Kinds of Fertilizer. Sulphate of ammonia has a slightly acid reaction and should not be used on land deficient in lime. It works a little more slowly than some other nitrogenous fertilizers and is therefore specially suitable where, for any reason, the application is made rather early.

After mid-April the more quickly-working kinds like nitro-chalk or nitrate of soda are best.

Method of Dressing. Until late April, the manure distributor can nearly always be used. After that the corn may be so high that it would suffer from trampling. In that case broadcasting by hand is best, the men straddling the rows. It is very important that the fertilizer should be distributed evenly.

(F. L. ENGLEADOW.)

Pig Feeding with Swill

The possibilities of the greater use of swill, or brock as it is known in Scotland, have recently been investigated by means of a questionnaire sent by the Pig Experiments Co-ordinating Committee to swill-feeding establishments such as Mental Hospital farms, supplemented by visits to eight other swill-feeding centres. The present note is a condensed version of the Committee's findings.

The use of restaurant and institution food waste in pig feeding is an old-established practice, but in Britain it was found to be usually confined to the neighbourhood of large towns and to large institutions. Very little use seems to be made of the refuse from households in the smaller urban areas. In Germany, the collection of household swill has long been highly organized, and special fattening farms using this material were in existence before the 1914-18 war. In the United States, garbage is collected by the authorities in a large number of cities, and either sold to pig feeders or used on municipal pig farms.

Composition and Impurities. The composition of swill is very variable and it is most unusual for it in itself to form a balanced ration. Frequently it contains excessive fat, which,

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if not removed, is liable to result in digestive trouble and soft, oily carcasses. At most institutions it was found that the fat was extracted from the waste meat before it left the kitchens, and the fat in the swill consisted mainly of uneaten scraps.

Certain other substances sometimes contained in swill are apt to be harmful. The presence of soap or soda induces scour; salt in quantity may result in salt poisoning. As it is impossible to remove these substances satisfactorily in solution, they should not be allowed to get into the swill tub. Other noxious articles, such as the rinds of oranges, lemon or grapefruit, fish bones, skewers, nails, sardine or other tins, knives and forks, bottles, etc., all of which through carelessness sometimes find their way into the swill tub, should be removed at the source or during a preliminary rake over of the collected material.

Some institutions devote separate containers to vegetable waste and thereby secure a particularly valuable food for sows and fattening pigs kept indoors. The vegetable material is useful in keeping pigs open when bran and middlings are difficult to procure.

Preparation. Swill should be collected daily. If left longer, meat wastes may putrefy and bread fragments may develop unpalatable moulds. After a preliminary raking over for lumps of fat, fish bones, etc., all swill must be thoroughly boiled for at least an hour to comply with the Foot-and-Mouth Disease (Boiling of Animal Foodstuffs) Order. This operation facilitates the removal of excess fat, which can be skimmed off. One successful feeder boils the swill for at least three hours, if possible for five. In this way he obtains a homogeneous pulp that mixes readily with the meal and rarely gives rise to stomach trouble.

Methods of Feeding. Considerable variation in practice was found, but some general principles emerged. It was not usually considered advisable to feed swill except in very small quantities to pigs below 80 lb. live weight, or to suckling sows. An all-swill ration was generally confined to empty and in-pig sows; it was not found suitable for fattening pigs or suckling sows.

Swill cannot be fed to formula. Successful feeding depends on the daily balancing of the ration, which in turn depends on the judgment of the pigman and his ability to assess the progress and condition of his pigs.

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Swill containing large quantities of meat was balanced by adding maize, middlings or barley meal, while that consisting largely of bread and potatoes required fish meal, soya-bean meal or some other form of protein.

The herd at one very successful centre received at 80 lb live weight a ration of 3-4 lb. made up of 60 parts weatings 15 flaked maize, 15 barley meal, and 5 parts each of fish meal and soya-bean meal. This was gradually reduced to 2 lb. per head and swill added to appetite. At 100 lb. live weight, the basic ration was 2 lb. of a mixture containing equal parts of middlings and barley meal, plus as much swill as the pigs would eat. This was continued to bacon weight, but varied slightly each day according to the composition of the swill and the condition of the pigs. If they were loose, the barley meal was increased; if constipated, the middlings proportion was raised, and in bad cases the middlings were replaced by bran.

In-pig and suckling sows were successfully fed at one centre throughout the year on swill and occasional raw potatoes. The sows ran out on clover layers and were housed in large wooden huts. In the morning, each received a bucket of swill spread on the ground, and at mid-day, if the morning supply of swill was short, a few raw potatoes were given. No meal was fed, even during suckling. The little pigs, from 3 weeks, were given selected scraps of swill in creeps.

Sows at another centre were given about 2 gal. of swill a day from service until a month before they were due to farrow, when they received in addition 2 lb. of weatings and 1 pint soaked beans. After farrowing, the swill was replaced by weatings until the pigs were a month old, when 1 part swill and 3 parts weatings were fed to sows and suckling pigs. On weaning, the pigs received 1 part swill to 4 parts weatings, the swill proportion of which was increased until the pigs reached 80 lb. live weight, after which the weatings were cut out. With the exception of fresh-cut grass clippings and kitchen refuse (uncooked potato peelings, cabbage leaves, etc.) the pigs were finished on swill—about 20 lb. per day. This herd of Middle White sows produced profitable porkers at about 120 lb. live weight.

It was evident from the investigations that, if properly handled, swill can be used in pig feeding with great success. The pigs reached bacon weight at a reasonable age and the bacon was of good quality. Naturally, a good deal more skill

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is required in the feeding of swill than of meal, and much depends on the pigman; much also depends on the care with which the swill is collected and prepared.

With experience, however, swill feeding becomes simple and highly successful. The full Report of the Committee contains examples of several different methods of feeding swill to various classes of pigs, with actual weights fed and particulars of foods used in combination with swill.

Land Drainage in War Time

The outbreak of war necessitated a review of existing plans in many spheres of work. As regards land drainage, such a review presented a dual aspect. On the one hand, the need for economy involved the postponement or curtailment of some improvement schemes until a more opportune time; on the other hand, the campaign for increased food production required all suitable land to be brought into use.

The Minister's war-time policy regarding the continuation of land-drainage work by Catchment Boards and Drainage Boards was communicated to them on September 30 last in the following terms:—

The Minister's view is that an essential pre-requisite to the success of the food production campaign is that agricultural land should be adequately drained, and it is therefore very desirable that any work should be proceeded with which is calculated to maintain or improve substantially the productivity of considerable areas of land within a reasonable period. In this connection, the Government's decision to plan for a war of three years' duration should be borne in mind.

The setting up, under the Defence Regulations, 1939, of the County War Agricultural Executive Committees, with certain powers relating to land drainage, naturally raised the question how the existing Drainage Authorities (including County Councils and County Borough Councils) and the War Executive Committees should co-operate in exercising their respective powers so as to achieve the maximum results without overlapping or confusion. The Committees were accordingly advised on October 2 of the powers and facilities which Drainage Authorities already possessed, and were recommended to consult with these Authorities at the outset when action on land drainage was contemplated in furtherance of the food-production campaign. At the same time, Drainage Authorities were informed of the advice given to the Executive Committees and urged to co-operate with them to the utmost of their power.

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Further, in emphasizing the great importance of the improvement of land drainage in relation to the food production campaign, attention was called to the need for making the fullest use of the grants available under Part III of the Agriculture Act, 1937. Their use was also urged in a circular letter, addressed to County Councils and County Borough Councils on November 10, explaining the extent to which the normal activities of those Councils were likely to be affected by the existence of the County War Agricultural Executive Committees.

In this connexion, the Minister recommended that, as it might be difficult under war conditions for Councils to undertake any considerable amount of land drainage, they should consider the desirability of inviting the appropriate War Agricultural Executive Committees to undertake the task of preparing and supervising such schemes as the Councils might formally submit for grant under the Agriculture Act.

On December 14, the Minister intimated in the House of Commons that the Government proposed to take further steps to secure the better draining of land in England and Wales.

As regards schemes of drainage submitted to the Minister for grant under Section 15 of the Agriculture Act, 1937, it has now been decided that all works, whether of a constructional character or not, are to be grant-aided at the rate of 50 per cent., and schemes carried out mainly by hand labour can continue throughout the year, in the same way as schemes carried out mainly by machinery, instead of being limited to the period October 15 to April 30 as hitherto. In addition, schemes affecting one holding only are also to be eligible for grant-aid.

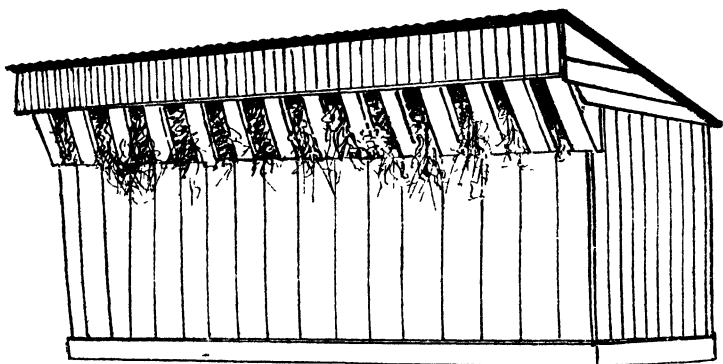
Further, the Government intends in pursuance of the proviso to Section 15 of the Agriculture Act, 1937, to ask Parliament to confirm an Order, to be made by the Minister, extending the period in which grants may be given for a further year, i.e., until July 31, 1941.

It is also proposed to invite Parliament to pass legislation empowering Catchment Boards to prepare and carry out schemes, at the request of the County War Agricultural Executive Committees, for the drainage of areas outside the jurisdiction of Internal Drainage Boards. Such schemes would be eligible for a Government grant of 50 per cent. of the approved cost, the remainder of the cost being met normally by the landowners or occupiers concerned.

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An Outdoor Hay Rack

It is important at all times to avoid waste, and at the present it is a duty. Through oversight or lack of thought, many examples of wasteful methods may be found on the farm. For example, sometimes when hay is being fed to outwintering stock, it is thrown from the cart in large forkfuls in a line determined more or less by the horse's idea of direction. If the animals are hungry, there will be a rush for the first heap, and perhaps a "scrum down" over it. Bovine intelligence in a matter of this kind only recognizes that the shortest distance between two points is a straight line, and con-



sequently, after snatching a bite from this first heap, "scrum half" and other members of the team will take the shortest cut to the next "pill" of hay, regardless of the effects of muddy feet on clean food. Invariably there is a good deal of waste of valuable material.

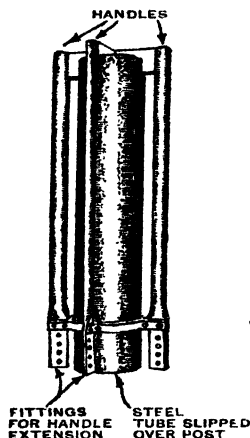
The illustration shows a combined storehouse and rack which might be constructed on skids. The store contains about a week's supply of hay for a suitable number of animals. When empty, it should be moved to a new site and re-filled.

It is not suggested that new timber be used for the construction of this rack—supplies are unobtainable for such purposes—but many farms possess the necessary material in the form of old sheds, old doors, scantlings and the like, that could be economically used in this way.

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Fencing Made Easier

The ploughing-up campaign may result in the need for new fences for dividing fields, and for other purposes. In this connexion, the simple post-driving device illustrated is of special interest. It can be used for driving quickly posts of every description, pointed or otherwise, without damage to the posts, and with entirely satisfactory results.



The tool consists of a round steel tube, furnished with two or four handles, and is manufactured in eight sizes, starting from one suitable for stakes approximately 1 in. diameter, or $\frac{3}{4}$ in. square, and increasing in size by 1 in. diameter per size, so that the largest is capable of dealing with posts of approximately 8 in. diameter, or $5\frac{1}{2} \times 5$ in. square. The size likely to be of most general use on the ordinary farm is one that can deal with posts up to 6 in. diameter, or $4\frac{1}{2} \times 4$ in. square.

Two men, one at either side, are normally required to work the tool, but for the largest two sizes it may be advisable to have four men to handle them. On the Moulton Institute Farm, we have used this device for the past three years, and have found that not only is there a considerable saving in the time and labour involved in erecting a fence, but that the posts are much firmer, and less liable to become loose, than when driven in other ways, or dug in. Two men can drive posts 5 ft. 6 in. long and 4×3 in square into the ground, to a depth of 18 in., at the rate of 30-40 an hour.

If it is desired to erect posts longer than the average length for fencing, the tool is used with extensions on the handles. The 4 in. size, fitted with extension handles, has been particularly useful when erecting posts 7 ft. 6 in. by $2\frac{1}{2} \times 2\frac{1}{2}$ in. square for poultry enclosures. Two men can erect 40 posts of this size quite easily in an hour.

Non-pointed posts can be dealt with almost as easily as pointed ones, and actually often go in straighter. It is not

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necessary to have posts which are the same thickness all through, provided the top part will fit into the cylinder, and the post is reasonably straight. It should therefore be possible for farmers to make full use, for fencing purposes, of spare timber which may be available on the farm.

(V. A. Lindsay.)

RECENT AGRICULTURAL STATISTICS

Agricultural Index Number

MONTHLY INDEX NUMBERS OF PRICES OF AGRICULTURAL PRODUCE
(BASE, 1927-29=100)

Uncorrected for
Seasonal Variation

*Corrected for
Seasonal Variation*

Month	1937	1938	1939	1937	1938	1939
January	90	97	90	85	90	84
February .. .	91	95	88	86	89	82
March .. .	90	88	85	90	88	85
April .. .	80	85	85	92	89	89
May .. .	81	82	77	88	90	86
June .. .	83	81	75	89	90	83
July .. .	82	86	80	88	94	87
August .. .	83	81	80	87	86	86
September ..	87	81	87	89	83	88
October .. .	93	80	91	89	82	87
November ..	99	80	102	92	82	94
December ..	100	90		92	82	

THE SAME, TAKING ACCOUNT OF PAYMENTS UNDER THE WHEAT ACT (a),
THE CATTLE SUBSIDY (b), AND GOVERNMENT PAYMENTS FOR MILK (c).

Month	1937	1938	1939	1937	1938	1939
January	92	99	95	86	93	89
February .. .	93	97	93	88	92	88
March .. .	92	91	90	92	91	90
April .. .	90	88	90	93	92	94
May .. .	83	84	82	90	92	91
June .. .	82	83	80	89	92	88
July .. .	83	88	85	89	96	93
August .. .	85	84	85*	89	89	91*
September ..	89	84	92*	91	86	93*
October .. .	95	91	96*	91	86	91*
November ..	101	94	106*	94	86	97*
December ..	102	94		94	86	

(a) Commenced August, 1932. (b) Commenced September, 1934.

(c) Commenced April, 1934.

* Provisional.

RECENT AGRICULTURAL STATISTICS

PROVISIONAL FIGURES OF WHEAT, BARLEY, OATS AND POTATOES ACREAGES IN 1939, WITH COMPARATIVE FIGURES FOR 1938

	Wheat		Barley		Oats		Potatoes		
	1939*	1938	1939*	1938	1939*	1938	1939*	1938	1938*
	Acres 000's	Acres 000's	Acres 000's	Acres 000's	Acres 000's	Acres 000's	Acres 000's	Acres 000's	Acres 000's
EASTERN:									
Bedford	34.1	35.9	4.8	4.7	12.4	11.1	7.3	10.1	11.1
Huntingdon	38.6	40.1	9.4	9.2	8.3	7.9	0.4	9.1	9.6
Cambridge	51.7	54.2	30.7	33.5	18.5	18.4	3.2	3.6	3.8
Isle of Ely	53.7	53.9	3.8	4.6	13.7	13.6	2.5	38.7	39.7
Suffolk, East	53.5	64.3	69.3	67.5	22.0	21.8	0.4	1.7	2.3
" West	49.1	53.2	50.5	46.5	15.0	15.1	0.4	1.9	2.2
Essex	107.6	115.2	63.9	60.7	35.5	36.7	2.1	13.7	17.3
Hertford	46.3	48.0	13.8	12.0	20.9	21.2	0.2	3.2	3.7
Middlesex and London	0.3	0.9	0.1	0.1	0.6	0.6	0.2	0.9	1.1
NORTH-EASTERN:									
Northfolk	119.2	123.9	184.6	176.3	53.9	52.7	2.8	21.3	23.7
Lincoln (Holland)	49.3	48.9	3.4	3.9	16.4	16.5	8.2	50.0	58.1
Lincoln (Kesteven)	65.0	66.1	35.9	37.9	20.6	20.5	2.9	15.6	18.8
" (Lundsey)	122.2	130.6	70.4	69.7	53.1	51.8	2.4	37.6	40.5
York, E.R.	85.2	92.0	56.6	55.6	65.7	63.6	1.2	10.8	12.5
SOUTH-EASTERN:									
Kent	35.1	36.7	16.1	15.1	21.8	22.2	3.5	11.6	16.4
Surrey	7.6	8.3	1.3	1.0	6.9	6.8	0.4	2.1	2.6
Sussex, East	12.3	13.3	0.6	0.6	10.6	10.3	0.4	1.5	2.1
" West	17.9	20.3	3.5	3.7	15.1	14.3	0.6	1.3	1.9
Berkshire	31.0	33.6	12.5	11.5	18.3	18.4	0.3	1.2	1.5
Hampshire	45.8	51.8	21.1	20.2	41.2	39.8	0.8	3.1	3.9
Isle of Wight	3.2	3.5	2.0	2.1	2.9	2.5	0.2	0.8	0.9
EAST MIDLAND:									
Nottingham	48.5	49.5	8.6	9.0	28.7	26.6	0.4	7.1	8.4
Leicester	21.4	22.7	2.6	2.8	10.3	9.0	0.1	1.8	2.1
Rutland	5.1	5.5	6.8	6.6	2.1	1.9	0.4	0.4	0.4
Northampton	37.6	38.8	10.6	11.5	12.6	12.0	0.1	1.5	1.6
Soke of Peterboro'	6.6	6.6	4.1	4.1	1.9	1.8	0.1	1.4	1.6
Buckingham	19.2	21.5	3.0	2.9	13.0	11.2	0.2	1.0	1.2
Oxford	38.3	42.4	15.6	14.5	21.3	20.9	0.1	1.6	1.7
Warwick	26.3	29.8	1.9	1.8	15.8	14.0	0.4	4.0	5.1

RECENT AGRICULTURAL STATISTICS

WEST MIDLAND :													
Salop ..	..	..	..	20.0	31.3	12.0	13.5	31.7	29.1	1.3	3.7	5.0	5.2
Stafford ..	..	..	..	14.9	17.2	8.9	8.0	18.7	16.8	0.5	3.5	4.0	4.1
Worcester ..	..	..	..	32.3	37.3	8.6	8.0	18.7	16.8	0.2	1.4	1.7	1.8
Gloucester ..	..	..	..	30.5	45.8	12.7	11.8	24.3	22.0	0.2	1.3	1.5	1.5
Wiltshire ..	..	..	..	18.0	20.7	6.1	5.7	20.8	19.2	0.1	1.1	1.1	1.2
SOUTH-WESTERN :													
Somerset ..	..	..	..	19.1	23.6	11.2	10.8	14.9	13.3	0.3	2.0	2.4	2.5
Dorset ..	..	..	..	15.6	17.8	8.4	8.0	16.3	14.7	0.2	1.0	1.2	1.3
Devon ..	..	..	..	22.9	30.3	21.3	20.4	83.5	83.5	0.7	5.5	6.2	6.7
Cornwall ..	..	..	..	8.5	10.5	8.1	8.6	41.0	43.3	1.1	3.5	4.7	4.5
NORTHERN :													
Northumberland ..	..	..	..	9.7	11.1	9.9	10.3	27.7	27.1	0.2	4.5	4.7	5.0
Durham ..	..	..	..	20.6	22.8	5.0	6.4	33.8	30.6	0.5	11.8	12.3	13.0
York, N.R. ..	..	..	..	39.7	47.5	48.3	46.8	55.5	51.5	0.9	11.4	12.0	13.1
" W.R. ..	..	..	..	67.7	73.5	15.1	14.2	60.1	56.9	0.8	25.3	26.0	27.6
NORTH-WESTERN :													
Cumberland ..	..	..	..	0.3	0.8	0.4	0.2	43.0	45.0	0.1	4.4	4.8	5.3
Westmorland ..	..	..	..	—	0.1	0.1	0.2	8.3	8.6	—	0.6	0.6	0.7
Lancaster ..	..	..	..	24.2	33.7	0.8	0.5	54.9	47.1	4.5	28.0	32.5	34.3
Chester ..	..	..	..	22.4	26.2	0.7	0.5	35.1	33.6	5.9	10.5	10.4	17.7
Derby ..	..	..	..	19.3	21.4	1.1	1.4	13.9	12.2	0.1	2.7	2.8	3.1
Stafford ..	..	..	..	26.0	28.4	1.7	1.8	21.2	19.7	1.2	9.4	10.5	11.4
TOTAL, ENGLAND (excl. Monmouth) ..													
				1,683.3	1,811.2	837.4	860.4	1,196.7	1,145.9	53.4	331.0	437.4	457.5
NORTH WALES :													
Anglesey ..	..	..	..	—	0.1	0.8	0.9	9.9	10.5	0.1	0.8	0.9	1.0
Gwynedd ..	..	..	..	0.1	0.1	1.2	1.4	7.7	7.3	0.2	1.3	1.5	1.6
Merioneth ..	..	..	..	0.1	0.1	1.0	1.1	7.1	6.8	0.1	0.7	0.8	0.8
Montgomery ..	..	..	..	3.0	4.5	1.7	1.5	15.3	15.3	0.1	0.8	0.9	0.9
Denbigh ..	..	..	..	1.5	2.3	2.2	2.5	17.1	16.2	0.2	1.1	1.3	1.4
Flint ..	..	..	..	1.2	1.8	0.4	0.4	5.5	5.1	0.1	0.8	0.9	1.0
SOUTH WALES :													
Cardigan ..	..	..	..	0.7	1.2	5.5	6.3	26.1	24.7	0.2	2.3	2.5	2.6
Radnor ..	..	..	..	0.5	0.6	0.5	0.5	11.2	11.0	—	0.4	0.4	0.4
Brecon ..	..	..	..	0.6	0.8	0.7	0.8	9.7	9.4	—	0.5	0.5	0.5
Monmouth ..	..	..	..	3.0	3.8	0.5	0.5	3.8	3.4	0.1	0.7	0.9	0.9
Glamorgan ..	..	..	..	1.6	2.5	1.2	1.3	7.4	6.9	0.3	1.4	1.7	1.8
Carmarthen ..	..	..	..	0.2	0.5	1.1	1.1	15.9	15.3	0.2	1.5	1.8	2.0
Pembroke ..	..	..	..	0.5	0.9	5.6	6.6	23.2	22.6	1.1	1.4	2.5	2.3
TOTAL, WALES (incl. Monmouth) ..				12.9	19.1	22.3	25.1	160.1	154.8	2.8	13.8	16.6	17.3
TOTAL, ENGLAND AND WALES ..				1,696.2	1,830.3	859.7	885.5	1,356.7	1,300.7	56.2	397.8	454.0	474.8

* Provisional figures—subject to revision

RECENT AGRICULTURAL STATISTICS

PROVISIONAL FIGURES OF PIG, SHEEP AND POULTRY POPULATION IN 1939, WITH COMPARATIVE FIGURES FOR 1938

	Pigs		Sheep		Poultry		
	1939*	1938	1939*	1938	Fowls over 6 mths old	Fowls under 6 mths old	Total
EASTERN :							
Bedford ..	41.9	41.7	68.2	68.2	138	221	342
Huntingdon ..	27.6	29.2	45.0	45.5	83	111	204
Cambridge ..	53.6	55.5	51.5	56.1	195	286	480
Isle of Ely ..	52.7	55.6	7.0	7.4	147	209	347
Suffolk (East)	144.7	139.8	88.8	93.1	110	519	920
Suffolk (West)	76.6	82.8	81.4	80.0	210	367	629
Essex ..	135.5	137.2	164.8	170.1	816	1,152	1,968
Hertford ..	44.8	47.6	61.2	66.7	228	319	575
Middlesex and London	15.3	19.1	4.6	5.5	22	51	57
NORTH-EASTERN :							
Norfolk ..	105.7	200.4	203.9	225.3	699	964	1,663
Lincoln (Holland) ..	63.4	65.4	111.0	131.1	224	331	555
" (Kesteven) ..	37.1	30.1	102.6	167.4	200	294	495
" (Lincolnshire) ..	105.0	103.4	398.2	396.5	730	969	1,691
York (E. Riding)	105.3	106.9	410.6	408.5	396	662	1,058
SOUTH-EASTERN :							
Kent ..	95.0	92.1	756.8	796.0	699	949	1,648
Surrey ..	30.1	31.5	33.0	34.5	198	353	551
Sussex (East) ..	36.9	35.5	153.1	157.9	302	464	766
Sussex (West) ..	30.9	29.5	62.9	62.9	209	328	536
Berkshire ..	39.8	37.3	75.7	75.1	188	311	499
Hampshire ..	79.7	75.3	111.8	139.3	526	714	1,240
Isle of Wight	19.5	20.4	13.9	15.3	30	56	92
EAST MIDLAND :							
Nottingham ..	48.6	47.9	112.3	140.8	307	426	733
Leicester ..	33.7	34.9	266.5	275.2	350	475	824
Rutland ..	3.6	3.5	62.8	63.9	35	49	84
Northampton ..	35.8	36.9	368.4	375.0	255	296	551
Sole of Peterboro' ..	4.0	4.4	15.6	15.2	23	28	51
Buckingham ..	45.2	45.3	198.5	202.2	229	343	572
Oxford ..	45.4	45.3	159.3	161.7	253	325	578
Warwick ..	46.9	49.1	301.4	308.3	319	416	735

RECENT AGRICULTURAL STATISTICS

WEST MIDLANDS									
Salop	111.5	107.3	577.0	576.8	616	393	1,419	1,482	
Warwick	60.2	61.3	209.3	209.9	409	682	683	684	
Gloucester	80.6	91.4	315.3	313.3	409	313	683	684	
Wiltshire	85.3	82.9	217.7	217.8	418	518	976	980	
Hereford	41.1	41.2	464.9	466.7	284	379	863	668	
SOUTH-WESTERN									
Somerset	134.6	132.7	378.6	381.4	768	856	1,623	1,655	
Dorset	48.6	49.5	149.8	154.4	320	387	714	712	
Devon	156.7	155.4	972.9	944.4	1,135	1,385	2,519	2,388	
Cornwall	195.9	186.5	287.4	233.1	683	930	1,012	1,566	
NORTHERN									
Northumberland	18.1	17.7	1,147.3	1,152.9	214	207	420	459	
Durham	29.9	30.2	297.7	294.8	275	333	668	578	
York (N. Riding)	93.5	99.3	812.1	805.6	688	840	1,534	1,493	
" (W. Riding)	149.6	155.3	751.3	759.7	1,392	1,733	3,125	3,175	
NORTH-WESTERN									
Cumbria	21.0	23.9	749.6	756.3	476	640	1,076	1,080	
Lancaster	4.6	16.9	432.3	479.1	291	218	409	444	
Westmorland	155.6	156.7	436.7	436.5	2,670	3,487	5,959	5,955	
Chester	111.3	111.3	146.7	146.5	681	515	1,067	1,067	
Derby	40.3	38.1	147.8	146.0	434	515	967	967	
Stafford	59.1	50.6	225.8	216.1	593	764	1,357	1,305	
TOTAL, ENGLAND (excl. Monmouth)	3,303.0	3,341.5	13,325.7	13,344.8	21,150	27,537	48,787	43,449	
NORTH WALES:									
Anglesey	10.6	11.3	178.9	178.6	91	69	160	163	
Gwynedd	10.7	12.4	347.1	332.7	158	102	230	215	
Caernarvon	5.5	5.8	442.5	430.8	57	37	94	99	
Merioneth	23.8	23.8	594.6	586.1	238	268	496	513	
Montgomery	24.9	26.1	524.2	512.0	167	101	328	315	
Denbigh	20.2	19.6	156.1	155.3	117	154	271	277	
Flint	20.2	19.6	156.1	155.3	117	154	271	277	
SOUTH WALES:									
Cardigan	17.3	19.6	347.6	323.5	203	171	371	387	
Radiol	4.2	4.4	354.2	319.4	80	81	102	103	
Brecon	7.9	8.3	531.7	513.7	182	80	108	109	
Monmouth	18.9	20.5	283.8	275.6	182	251	434	441	
Glamorgan	10.3	10.5	359.7	359.7	140	169	315	315	
Caerphilly	12.4	12.4	358.7	343.3	177	203	355	365	
Pembroke	25.6	29.3	185.6	184.0	133	160	373	396	
TOTAL, WALES (incl. Monmouth)	257.1	222.7	4,641.4	4,567.7	1,943	2,608	3,951	4,120	
TOTAL, ENGLAND AND WALES	3,561.0	3,564.3	17,967.1	17,912.5	23,093	29,645	52,738	52,539	

* The figures for 1939 are provisional.

RECENT AGRICULTURAL STATISTICS

PROVISIONAL ESTIMATES OF PRODUCTION AND YIELD OF CERTAIN CROPS, ENGLAND AND WALES, 1939

Crop	Acreage, 1939	Estimated Total Produce 1939	Estimated Yield per Acre		
			1939	1938	1929-38 Average
	ooo's	ooo's			
Wheat	1,683	1,555 tons	18·5 cwt.	20·3 cwt.	17·8 cwt.
Barley	910	794 "	17·5 "	18·1 "	16·2 "
Oats	1,358	1,119 "	16·5 "	16·4 "	15·8 "
Potatoes	454	3,312 "	7·3 tons	7·3 tons	6·6 tons
Turnips and Swedes	394	4,947 "	12·5 "	12·1 "	11·3 "
Mangolds	209	3,938 "	18·8 "	16·9 "	18·2 "
Beans for stock- feeding or seed	133	109 "	16·4 cwt.	16·3 cwt.	16·3 cwt.*
Peas do.	37	23 "	12·7 "	15·8 "	14·8 "
Sugar-beet	336	Not yet avail'bl	approx 9 tons	6·6 tons	8·6 tons
Hops	18·8	288 cwt.	15·3 cwt.	13·9 cwt.	12·9 cwt.
Seeds Hay†	1,303	1,700 tons	26·1 "	21·6 "	26·1 "
Meadow Hay‡	4,612	4,535 "	19·7 "	14·8 "	19·3 "

Peas and Beans harvested as Corn up to 1934.

† Hay from Clover, Sainfoin and Grasses under rotation.

‡ Hay from Permanent Grass.

PROVISIONAL FIGURES OF ACREAGES OF SMALL FRUIT, CERTAIN VEGETABLES, FLOWERS AND NURSERY STOCK AND CROPS UNDER GLASS, ENGLAND AND WALES, 1939

—	1939	1938
SMALL FRUIT :		
Strawberries	18,705	20,583
Raspberries	4,140	4,063
Currants, Black	10,303	10,038
Currants, Red and White	2,337	2,358
Gooseberries	9,162	9,333
Loganberries and Cultivated Blackberries	2,511	2,327
TOTAL	47,218	49,302
OTHER CROPS :		
Hardy Nursery Stock	10,301	10,478
Daffodils and Narcissi (not under glass)	4,636	4,494
Other Bulb Flowers (not under glass, including area planted for dry bulb trade)	3,167	2,627
Other Flowers (not under glass)	5,785	5,952
Tomatoes, grown in the open	233	325
Tomatoes, grown in glasshouses	1,861	1,675
Other crops (Fruit, Vegetables, Flowers and Plants) grown in glasshouses	1,133	1,102
Crops (Fruit, Vegetables, Flowers and Plants) grown in frames	273	400
Celery	6,650	6,450
Rhubarb	7,243	7,218
Asparagus	2,605	2,610
Lettuce, Cos and Cabbage	5,857	4,768
Carrots	16,116	15,517
Onions	1,717	1,693
Crops not specified elsewhere	32,109	29,263
TOTAL	99,686	94,572

RECENT AGRICULTURAL STATISTICS

PROVISIONAL FIGURES OF NUMBERS OF DUCKS, GESE AND TURKEYS,
ENGLAND AND WALES, 1939, WITH COMPARATIVE FIGURES FOR 1938

	Ducks		Geese		Turkeys	
	1938	1939*	1938	1939*	1938	1939*
England ..	000's 2,125	000's 2,022	000's 462	000's 415	000's 681	000's 603
Wales ..	213	211	147	137	108	90
TOTAL ..	2,338	2,233	609	582	789	693

RECENT OFFICIAL PUBLICATIONS

The Ministry's Advisory Publications. Since the date of the list published in the July, 1939, issue of this JOURNAL (p. 410), the under-mentioned Advisory Publications have been issued by the Ministry.

BULLETINS:

- No. 28.—*Fertilizers in Modern Agriculture.* (3rd Edition.) 4s. (4s. 6d. post free). Extensively revised on the basis of results obtained from a series of uniform and co-ordinated experiments in progress at various research centres.
- No. 30.—*Rats and How to Exterminate Them.* (4th Edition.) 6d. (7d. post free). An amended and rearranged edition, including a note on measures for the control of grey squirrels.
- No. 48.—*Rations for Live Stock.* (10th Edition.) 1s. 3d. (1s. 5d. post free). Considerably revised and extended in the light of recent information.
- No. 96.—*Commercial Flower Production: Part I. Spring Flowers and Flowers Grown under Glass.* (2nd Edition.) 2s. 6d. (2s. 9d. post free).
- No. 112.—*Commercial Flower Production: Part IV. Flowering Plants in Pots.* 2s. (2s. 2d. post free).
- No. 117.—*Diseases of Bulbs.* 4s. (4s. 6d. post free.) Provides the grower with an account in popular language of the symptoms, spread and control of each of the common diseases of bulbs, and furnishes the plant pathologist and research worker with a guide to the literature on the more uncommon diseases and on the technical aspects of the subject.
- No. 120.—*Root Vegetables.* 6d. (7d. post free). A concise account of cultivation, storage, and preparation for market of all the well known root vegetables (with the exception of potatoes).
- "Growmore" Bulletin No. 1.—*Food from the Garden.* This has been specially written to meet the needs of the half million new allotment holders and the many thousands of gardeners who will be turning their attention from flowers to food. Clear guidance is provided on such primary matters as soils, manuring, breaking up

RECENT OFFICIAL PUBLICATIONS

grass, cultivation, laying out the plot, cropping, control of pests and diseases and storage of the produce. 3*d.* (3½*d.* post free).

Copies of the above are obtainable at the prices mentioned from the Sales Offices of H.M. Stationery Office or through any bookseller.

ADVISORY LEAFLETS :

- No. 42.—Codling Moth. (Revised.)
- No. 60.—Farmyard Manure. (Revised.)
- No. 76.—Poultry Mites. (Revised.)
- No. 131.—Production of Fat Lambs. (Revised.)
- No. 161.—Rabbits for Fur and Flesh. (Revised.)
- No. 199.—Wireworms. (Revised.)
- No. 243.—Making Silage without Expensive Buildings. (Revised.)
- No. 295.—Mastitis in Cattle. (New.)
- No. 298.—Salmonella Infections of Ducks and Ducklings. (New.)
- No. 299.—Brussels Sprouts. (New.)

Copies of any of the above-mentioned leaflets may be purchased from H.M. Stationery Office, York House, Kingsway, London, W.C.2, or at the Sale Offices of that Department at Edinburgh, Manchester, Cardiff, and Belfast, price 1*d.* each net (1½*d.* post free), or 9*d.* net per doz. (10*d.* post free).

Single copies of not more than 20 leaflets may, however, be obtained, free of charge, on application to the Ministry. Further copies beyond this limit must be purchased from H.M. Stationery Office, as above.

A list of the Ministry's publications, including bulletins and leaflets on agriculture and horticulture, may be obtained free and post free on application to the Ministry.

" GROWMORE " LEAFLETS :

To supplement the ordinary Advisory Leaflets and to provide essential advice to agriculturists on their war-time problems, a special series of " Growmore " Leaflets is now being issued. Single copies of any of the leaflets listed below may be obtained *on application to the Ministry only* (copies are not obtainable from H.M. Stationery Office). Further leaflets in this series are in preparation.

- No. 1.—Vegetable Production in Private Gardens and Allotments.
- No. 2.—Advice to Poultry Keepers. I.—Grain Feeding.
- No. 3.—Making the Most of Potash Supplies.
- No. 4.—Rye as a Grain Crop.
- No. 5.—Poultry Keeping for Householders.
- No. 6.—Growing Two Corn Crops in Succession.
- No. 7.—Pigs in War Time. (a) Feeding on the Farm.
(b) The Cottager's Pig.
- No. 8.—Economy in the Feeding of Dairy Cows.
- No. 9.—Healthier Fruit : Disease Control in Private Gardens.
- No. 10.—Unsaleable Potatoes : Their Use in Animal Feeding.
- No. 11.—Pests and the Breaking of Grass Land.
- No. 12.—Economy in Horse Feeding.

NOTICES OF BOOKS

Instructions for Dealing with Rabbits. Compiled by Capt. C. W. Hume. Pp. 20. (London : Universities Federation for Animal Welfare. 1939. Price 3*d.*)

This new edition gives detailed information on fumigation, long-netting, rabbit-proof fencing, ferrets and ferreting, shooting, etc., together with the text of the Prevention of Damage by Rabbits Act, 1939, and a summary of the provisions of the Act, which lays on occupiers of land the onus of keeping down rabbits.

NOTICES OF BOOKS

Grass-Drying on the Farm: A Summary of Three Years' Experiences. By R. N. Dixey and J. B. Butler. Pp. 64. (Oxford: Agricultural Economics Research Institute. 1939. Price 1s. 6d.)

This report, based on detailed records of costs and experiences of various farmers, offers the conclusion that, taking one year with another, an efficient drier may be expected to produce dried grass of an average crude protein content of 16 per cent. at about £5 5s. per ton. A full discussion and analysis of the advantages and the difficulties of grass-drying is included.

British Isles Conference on Agricultural Co-operation, 1939. Report of Proceedings. Pp. x+112. (London: P. S. King. 1939. Price 2s. 6d.)

Reprints of the main papers and reports of the general discussions. Of particular interest are those on Crop Drying, Wool Marketing, Credit and Co-operative Distribution of Agricultural Requirements.

Cheese. By Lucius L. Van Slyke and Walter V. Price. Pp. viii + 358. Illus. (New York: Orange Judd Publishing Co., and London: Kegan Paul, Trench Trubner & Co., 1938. Price \$3.50.)

This book has for many years been regarded as a standard treatise in this country by dairy students and factory managers. A revised and enlarged edition will therefore be welcomed, and the additional sections on Soft Unripened Cheese and Processed Cheese are opportune.

The Principles of Insect Physiology. By V. B. Wigglesworth. Pp. viii + 434. Illus. (London: Methuen. 1939. Price 30s.)

Dr. Wigglesworth has here provided a standard work on insect physiology which will be of great value to advanced students and research workers. The book has been written to meet the requirements of students of general entomology and comparative physiology, and to assist economic entomologists who require a knowledge of insect physiology in order to appreciate the principles underlying practical measures of control or to understand properly the ecology of insect pests. The book is fully illustrated and is provided with copious references. It is admirably turned out.

Botany of the Living Plant. By F. O. Bower. 3rd Edition. Pp. xii + 700. (London: Macmillan & Co. 1939. Price 25s.)

Professor Bower's "Botany of the Living Plant" is too well known to need any introduction, and the publication of a third edition is an event which will be welcomed by all who have to learn or teach botany. The author has had the assistance of Professor J. M. F. Drummond and Dr. G. Bond in preparing this new edition, in which information concerning the more important recent advances in the subject have been incorporated. The author, nevertheless, states in the preface that he holds himself fully responsible for the text as it stands. This well-illustrated book is written in a lucid style, and can be thoroughly recommended to all who wish to acquire a reliable knowledge of the fundamentals which form the basis of botanical science.

Principles and Practice of Poultry Husbandry. By T. Newman. Pp. x + 188. Illus. (London: English Universities Press, Ltd. 1938. Price 5s; cheap edition, in paper covers, 2s. 6d.)

This book by Mr. Tom Newman, who needs no introduction to the poultry public, will be welcomed by many poultry-keepers. The book is clearly written and attractively produced. While not breaking new ground in any important respect, it deals comprehensively with all the departments of poultry husbandry in an interesting and concise style.

NOTICES OF BOOKS

Plant Hormones and their Practical Importance in Horticulture. By H. L. Pearce. Pp. 88. (East Malling: Imperial Bureau of Horticulture and Plantation Crops. 1939. Price 3s. 6d.)

This memorandum should greatly appeal to the practising horticulturist who seeks a reliable and readable guide to the recent developments in the use of plant hormones to stimulate root growth. The literature of this complex subject has grown with a bewildering rapidity in the past few years, and the busy grower will be grateful for the tables in which the results of nearly 1,000 experiments are clearly summarized.

Fruit Crops, Principles and Practices of Orchard and Small Fruit Culture. By T. J. Talbert and A. E. Marneck. Pp. 345. (London: Ballière, Tindall & Cox. 1939. Price 19s.)

This authoritative account of North American fruit growing practice by two well-known Professors of Horticulture is a valuable addition to the list of American books on agricultural and horticultural subjects, and the English publishers are to be congratulated on their enterprise in issuing the book in this country. The practice of fruit growing is one of the branches of agriculture which varies somewhat from one country to another, but although modifications of practice are necessarily called for, the scientific principles underlying all practice remain the same, and a volume of this character must rank as a text-book valuable as a work of reference to students and progressively minded growers alike.

The book is of a comprehensive character, dealing with the cultivation of the whole range of fruits and nuts commonly grown in the open in temperate zones. Two interesting chapters at the end of the book are devoted to methods of grading, packing and marketing in vogue in the United States.

Growing Scotland's Food. By Allan Fraser. Pp. 39. (Edinburgh and London: Oliver & Boyd. 1939. Price 1s.)

Dr. Fraser first gives a concise account of the state of Scottish Agriculture and then proposes a policy for its restoration and preservation. This pamphlet was written early in the year, and the changed conditions add only to its importance.

His examination of the condition of farming in Scotland reveals a far from prosperous agriculture, with land going out of cultivation and an exodus of rural workers each year at an alarming rate. The policy he suggests is framed not only to restore prosperity to Scottish farmers, but to add to the health and happiness of the nation. He advocates an effective subsidy in oats—a measure which has now been put into operation. But he would stipulate that if the State grants subsidy it should also direct policy.

The policy also includes the establishment of Smallholdings on a partnership basis between the State and the smallholders on the Metayagé system, the establishment, under National Trust, of holiday camps in the Highlands for the mutual benefit of farmer producers and holiday-maker consumers.

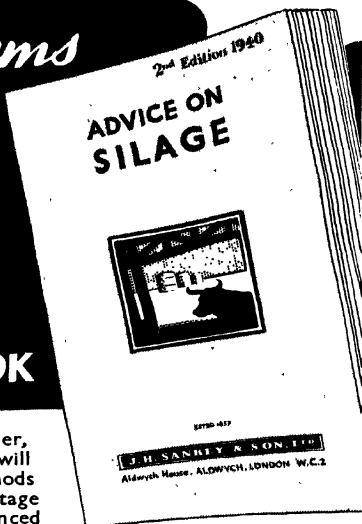
He discusses at length the place and importance of research and education, and would establish a chain of experimental farms which would demonstrate economic as well as scientific farming. Attention is drawn to the need at colleges for a better practical training, and, for the town boy seeking a farming career, more opportunities and an easier passage back to the land.

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The Food Front

Britain's food front lies in her fields and farmsteads. The Government have fixed the objective which farmers must strive to reach for this year's harvest—2 million more acres under the plough—and have pledged themselves to do all in their power to create and maintain the conditions which are necessary to enable farmers to achieve that objective. On the subject of labour, the Prime Minister, in his address to Chairmen of County War Agricultural Executive Committees on February 28 last, gave a definite assurance that the Government would take whatever steps were necessary to see that the crops when grown were harvested, and on the subject of prices he said: "Our purpose is to fix reasonable prices, and in fixing these prices we feel that since we are asking farmers to do things that they would not do in the ordinary course of their farming we, the Government, must accept the responsibility of seeing that conditions are such as to enable farmers to make these efforts."

The Prime Minister endorsed on behalf of the War Cabinet the statement made by the Minister of Agriculture and Fisheries in December last, that "If the increase in home production that we want is to be obtained, then the prices must be such as would give a reasonable return to the farmer and enable the farmer to pay a fair wage to the worker." Referring to the position of agriculture after the war, the Prime Minister added—"The Government are determined that, if they are in office, agriculture shall not a second time be allowed to collapse like it was the last time. I say that without hesitation, and with full confidence, because it is founded upon the conviction we all hold that a prosperous agriculture is just as important for this country as a prosperous industry."

There is perhaps scarcely any need to stress the paramount importance of obtaining the maximum amount of foodstuffs from our own soil. When speaking at Nottingham on

February 17, the Lord Privy Seal, after referring to the need for conserving our foreign exchange, stated that the purchases of foodstuffs from abroad are the biggest item in our foreign spending. We must, he said, grow more food at home. That is the great constructive plan that lies open to us. To make a fuller use of our natural resources is good husbandry and sound economy. Not only shall we get better and fresher food and effect a saving in our stocks of gold and foreign exchange, but by this economy we can, in the words of the Lord Privy Seal, "emerge from this war in one respect at least sounder, better off, wealthier than when we went into it, for we shall have well-tilled fields where we grew thistles, ploughland where we had moorland, and a prosperous countryside where we had a region of rural distress."

At the end of the last war, the area under the plough in England and Wales was $3\frac{1}{2}$ million acres greater than in September, 1939. We have started to redress the balance by planning to plough and sow 2 million acres as a first instalment. Owing to exceptionally unfavourable weather there are arrears which it will require a very special effort to catch up. But the task is not impossible. There is a large reserve of power on most arable farms and large numbers of tractors and implements have been distributed throughout the countryside. There are usually horses where there are no tractors. If formerly a man and his team could do their acre a day, the same "strength" can do it again. With energy and determination the national task can be accomplished.

The greatest latitude possible is being allowed to the farmer in his choice of the crops to grow on newly ploughed up land. He is obviously in the best position to know what crops suit his particular fields and what crops will best fit in with the general economy of the farm. It cannot be too strongly emphasized, however, that throughout the whole of the war period the situation with regard to imported animal feeding stuffs is bound to be difficult and uncertain, maybe increasingly so, although the Government will do all in its power to help. Farmers should therefore in their own interests grow the maximum possible amount of feeding stuffs for our live stock from our own soil—more crops and better grass.

Those who hesitate to reduce their grass land by ploughing should reflect that any temporary inconvenience will quickly be forgotten in the satisfaction of contemplating a comely oat-stack or a bulky clamp of mangolds.

It would be safer, some may say, to let grass stand than risk the failure of an arable crop. All farming is a gamble—between the inherent skill of the British farmer and the indeterminate forces of nature. And the farmer generally wins. What has been done can be done again. Now, as never before, is the time to try.

A Special Issue

In the preparation of each issue of the JOURNAL in the past it has always been the Editorial aim to cater for as wide an agricultural public as possible. So great in scope is the art of agriculture and so many are its related sciences, that the attainment of this object has rarely presented difficulty; and the temporary abandonment of this policy—as shown in the present issue—is attributable not to a narrowing of interest, but to a vivid awareness of immediate problems.

We are on the threshold of spring. The early bite and the promise of the seasonal flush, together with the natural optimism of the husbandman, will dispel much of the shadow that overhung many farms, particularly livestock farms, this difficult winter; but such is the relentless character of the farming code that the farmer must perforce look at spring with winter in his eyes. For by his planning and his sense of management at this season he decides the welfare, perhaps the fate, of his stock nearly a year hence.

It is for this reason that the JOURNAL is on this occasion so largely devoted to the subject of ensilage, one of the few ways in which the farmer can make sure of a succulent food supply for his stock next winter. Many aspects of the subject are dealt with in the following pages, from the making of a high-protein feed from specially grown protein-rich material, to the rough and ready methods of saving a spoiling hay crop. But for the newcomer, whose needs require more detailed treatment than can be afforded in an article, the Ministry has prepared a special "Growmore" Leaflet (No. 28), copies of which will shortly be obtainable free on application.

While the hazards of war are about our shores, no amount of cash or of credit can guarantee an uninterrupted food supply to the people and the animals that populate this island, but ensiled crops are riches banked against any misfortune, and, further, every silo filled helps to cheat the torpedo of a target.

THE MAKING OF HIGH-QUALITY SILAGE

W. R. PEEL AND S. J. WATSON

High-quality silage can only be made from young grass cut in May or from leafy aftermath grass in late summer or autumn, or from young clover, young lucerne and from other fodder crops if they are cut when young and far from the stage of maturity. All these materials are rich in protein, and if they are to make good silage some sugary material must be added when they are ensiled. The sugary material ensures the development of the right type of fermentation, i.e., lactic acid fermentation. Further, filling must be done with care, because a certain amount of heating must take place. It is on these two points that the making of high-quality silage depends.

The Silo. Silage of the highest feeding value cannot be made from high protein crops in a stack or clamp. If a tower or other type of silo is available, it should be used; if not, rather than incur the cost of a large silo, it is better to use one of a portable type made in wood, concrete, iron, or wire-mesh lined with paper, each of which has much to recommend it. The circumstances must decide whether the silo should be erected near the buildings or in a field, whether it should be a permanent structure, or whether its position will be changed in the following year. For the latter, the only preparation the site requires is the removal of the turf to one spit deep over an area slightly larger than that of the bottom of the silo. Soil to a depth of 4-6 in. is dug out over the whole site and stacked with the turf on one side. Both turf and soil will be required later for covering the silo when filling is completed. Having prepared the site, the first ring of the silo is erected; many portable silos are made in sections, several sections forming a bottom ring, on top of which another or more rings are placed. The bottom of this ring must be kept level so that the sides are as nearly vertical as possible. The other equipment needed at the site includes a barrel (any sort of barrel will do) in which to mix the molasses, which is the most suitable form of sugary material to use. A gauge stick should be made by cutting notches for every second or third gallon. In addition, an ordinary 2-gal. garden watering can or a semi-rotary pump and hose is required for applying the molasses solution.

Cutting the Crop. The crop can be cut with an ordinary mowing machine; if it has a cutter bar with double fingers,

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so much the better, for a closer and cleaner cut can then be made. After cutting, the swathes can be swept together by a side-delivery rake, two or three swathes into one according to the weight of the crop, and from here it is a simple matter—and not nearly so laborious as some people imagine—to fork into carts. A cutlift will obviate the collecting and forking on to carts. The farmer must decide for himself whether the acreage he intends to cut and make into silage justifies the expenditure on this most useful implement.

Filling the Silo. When young leafy grass is to be ensiled, the filling of the silo must be slow and can be done with the ordinary farm labour even on a small farm. For instance, where a silo of 15 ft. diameter and 10-12 ft. height, having a capacity of about 40 tons, is to be filled, about one acre of grass should be cut each morning. The grass is carted and put into the silo when labour is available between milkings on a dairy farm. Experience gained on small dairy farms has shown that this work can be done by two men. With regular daily filling it takes about a fortnight to finish the job.

Rapid filling with young grass is not desirable, especially at the start, for the lower layers of grass in the silo *must* be allowed to heat up to between 80° and 100°F. The temperature can be gauged by pushing the arm down into the mass each morning before filling starts. The grass should feel warm; if not, filling should be discontinued for 24 hours. If it has not been allowed to heat, the silage will be sour, smell of butyric acid and will have lost much of its feeding value. Grass which is very wet should not be packed as tightly as grass which is fairly dry. With the latter, tramping of the grass as filling proceeds must be thorough.

Where big acreages are to be cut and made into silage, and where more farm labour is available than in the example given above, it is advisable to have two or more silos in operation on alternate days. In this way each silo is given 24 hours in which the grass can heat up. When clover or lucerne is ensiled, filling can be more rapid, for the crop does not pack so tightly, but more tramping is necessary.

The amount of molasses required varies from 20 to 25 lb. per ton of fresh grass or clover and 30 lb. per ton of lucerne. The quantity required daily can be calculated by estimating the weight of crop to be ensiled. For example, for every four tons of young grass or clover, 80 lb. (20 lb. per ton of grass) of molasses are required, or about 8 gal. This quantity is

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measured out into the barrel and an equal volume of water added, bringing the total up to 16 gal. To this must be added another 8 gal. of water to bring the total up to 24 gal., or 6 gal. of solution per ton of grass ensiled, which is the very minimum quantity per ton it is possible to apply evenly. Where the quantity of molasses used per ton is 30 lb., then 12 gal. of molasses is required for the 4 tons of crop. To this, only 12 gal. of water are added, bringing the total up to 24 gal. or 6 gal. of solution per ton of crop. It is often well worth while making up the solution overnight so that there is no delay in the morning. If a little hot water is used, the molasses will dissolve rapidly. The molasses solution should be sprinkled as evenly as possible on the grass as it is ensiled, a sprinkling being given for every 6-in. layer.

In filling, always keep the whole surface of the grass well trodden and the centre well "hearted up." In a 15 ft. diameter silo, the centre should be 3-4 ft. higher than the sides. If this is done, the herbage will settle outwards and keep the edges tight against the walls of the silo. If the centre is not kept well up, the silage will settle in the shape of a saucer and will shrink away from the walls of the silo; air will get in, and there will be considerable waste. A good plan is to put all available men on treading the centre of the silo at the end of each day's filling.

Sealing Off. When the silo is full, a layer of old sacks or paper is placed on top and covered with earth to act as a seal. The layer of soil should be 4-6 in. thick and thoroughly packed so that at the finish the top is dome shaped. If more soil is available, it should be put on top to weight down the silage, the total depth being at least 12 in. If the extra soil is not available the weighting can be done with stones, or sleepers. After the silage has settled, which will take about 10 days, the upper part of the silo (the oversilo) is removed and a rough thatch placed on top to keep out rain.

The walls of a sectional silo may be removed after a fortnight, but if this is done some waste from mould will occur. This will not usually penetrate for more than 3-6 in. into the stack. The longer the structure can be left, the less the waste. The advantage of being able to remove the sections is that they can be used for making another lot of silage. Thus, a sectional silo is filled with young grass in May, and in August or September the structure is removed from the silage and again used for filling with aftermath grass.

SILAGE AS A FEEDING STUFF, AND HOW TO OBTAIN THE MAXIMUM FEEDING VALUE FROM IT

S. J. WATSON

Of all the foodstuffs produced on the farm, least is probably known of silage, but since in some of its forms it will replace imported feeding stuffs, it may be a factor of prime importance at the present time. Past experience has led the average man to think of silage as a substitute for hay—a roughage. While this may be true of commonly known forms of arable silage, it is certainly not fair to the best types of silage made from short grass, lucerne, or clover.

It should be understood at the outset that the modern process of making silage, when applied to grass, is not competitive with hay-making, but complementary to it. The hay provides the roughage necessary for the maintenance portion of the ration, the silage the nutrients necessary for the production of milk or growth.

In bad hay-making weather, however, it is an advantage to be able to ensile the material which would otherwise be partly, or sometimes almost completely, wasted. This practice uses grass at a much more advanced stage of growth than is usual for the best silage, and the product will go to the maintenance part of the ration.

It was once common to think of silage as replacing roots. This is not a sound comparison, because silage is much richer in digestible protein, even when made from such crops as oats and vetches or grass cut at an advanced stage of growth.

High-quality Silage. This is a very important category, and should prove a most valuable source of protein-rich food on the farm. When well made, it may be regarded as a watered concentrate which will directly replace dairy cake or similar foods. The protein in the dry matter will exceed 16 per cent. and may often be much higher.

There are three silages in this class, and of these the most important is made from grassland herbage cut at a young, leafy stage of growth. Herbage cut in May or in the autumn, up to a length of 6 in., is used, and the silage is all leaf. Such silage can be made without difficulty and with ordinary farm

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implements. The addition of molasses is necessary, since the crop at this young stage is short of the carbohydrates which are used to produce the desired acidity in the silo.

Lucerne and clover will also give silages of high feeding value if cut before they are too mature and properly made. Added molasses is an advantage, and almost essential if good silage is to be made from such protein-rich material.

	<i>Per 100 lb. of Crop as Fed</i>		
	<i>Dry</i>	<i>Starch</i>	<i>Digestible</i>
	<i>Matter</i>	<i>Equivalent</i>	<i>Crude Protein</i>
	<i>lb.</i>	<i>lb.</i>	<i>lb.</i>
High-quality grass silage ..	20	12.0	2.8
Lucerne silage	17	6.6	2.5
Clover silage	20	8.5	2.7

It will be noticed that digestible crude protein is quoted rather than protein equivalent. This is a fairer measure of the value of the protein in silage, as there is always a simplification of the protein during the ensilage process, but the products do not fall far short of the original protein in good silage.

The simplest way to feed silages of this type would be to allow for each gallon of milk:—

20 lb. molassed high-quality grass silage,
or 28 lb. molassed lucerne silage,
or 25 lb. molassed clover silage.

In such a ration the molassed grass silage would be properly balanced, and 56-60 lb. could be fed for 3 gal. of milk, together with a maintenance ration of 16-20 lb. of good hay, but the clover silage would be somewhat short in starch equivalent and high in protein, whilst the lucerne silage would be even more unbalanced. To get a true balance, 20 lb. of good clover silage and 1 lb. of crushed oats or barley should be fed for every gallon of milk. With lucerne silage, 20 lb. would be needed plus 1½ lb. of cereals. If the silage were used to feed for 1 gal. only, this adjustment with cereals is not necessary, especially since oats and barley will be needed for other purposes, but for more than 1 gal. clover and lucerne silage must be balanced. The dry matter needed for each gallon of milk is only 4 lb. where molassed grass silage is used, rising to 5 lb. with clover silage.

Each of these rations would replace the usual mixture of 3½ lb. of oil cakes and cereals which are so well known as dairy meals, or cubes. With growing stock, it is common to

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feed 3-3½ lb. of a cake mixture per head daily in addition to hay, roots or straw. These concentrates could be replaced entirely, or in part, by good quality silage.

Intermediate Silage. Much of the silage made from grass-land herbage is cut at a more advanced stage than is suitable for the high-quality grass silage mentioned above. For example, surplus grass in early summer is allowed to grow to what may be called the pre-hay stage, or autumn grass is allowed to grow for as long as possible and become fairly mature. The resulting silages contain between 12 and 15 per cent. of protein in the dry matter, and are really roughages, though richer than average meadow hay, which too often is much lower in protein than is commonly thought.

There are also arable silages, usually made from cereals and legumes; oats and vetches are common constituents of such silage mixtures. To these may be added peas or beans, and the oats may be replaced in part or wholly by other cereals. Such materials are cut at a fairly advanced stage of growth and are relatively low in protein and should be classed as roughages.

With regard to feeding of these intermediate silages, it is best to consider them as falling in the category of low-quality silage, described below, but it should be noted that they do not fall far short of being a production ration, and when supplies of feeding stuffs are short, 20-25 lb. can be fed for the first gallon of milk or to replace cake in the ration of young growing stock.

Low-quality Silage. The term low quality refers to the relation between the protein and starch equivalent, and is in no way a condemnation of the silage. This class includes poor grass silage, which is still edible, and grass silage made in the stack. This last too often heats and gives a sweet silage. Though the sweet types of silage are always palatable, their digestibility is low, particularly the protein, so they have not the feeding value of other types. Silage made from grass at the full-flower stage, often made when hay is impossible, comes into this class, even where molasses are used and the process has been carried out in a container or silo. It should be noted that with care and experience it is possible to make really excellent silage in the stack, but the best results are not generally obtained by this method.

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Maize, now becoming a fairly common crop in the south of England, makes good silage, but, as it is low in protein, it should be classed with the low-quality silages.

Feeding Low-protein Silage. The following table of feeding values covers both the intermediate and low-quality silages:—

	<i>Dry Matter lb.</i>	<i>Per 100 lb. of Crop as Fed</i>	
		<i>Starch Equivalent lb.</i>	<i>Digestible Crude Protein lb.</i>
Low-protein grass silage (pre-hay stage)	25	14.9	2.1
Oat-and-vetch silage	25	10.5	2.0
Stack and poor-grass silage	25	11.8	1.5
Maize silage	20	11.5	1.4

These compare most nearly with good hay and can be used to replace it, though in some there is an excess of protein which can, if need be, help the production ration. A simple table can be drawn up as a basis for the use of low-protein silages in terms of hay:—

4½ lb. average meadow hay is equal to :
 9 lb. low-protein grass silage (made at the pre-hay stage),
 or 11 lb. oat-and-vetch silage,
 or 11 lb. stack or poor-grass silage,
 or 11 lb. maize silage.

These amounts provide the necessary food for the maintenance of 2 cwt. of live weight, though with the low-protein grass and oat-and-vetch silages there is an excess of protein.

For a 10 cwt. cow, five times these amounts would be needed for maintenance, i.e., 21 lb. of hay or 55 lb. of oat-and-vetch silage. The latter contains an excess of protein that is nearly enough for a gallon of milk, and this 55 lb. of silage with 3 lb. of cereals would be enough for maintenance and the production of the first gallon of milk.

From the foregoing information, it should be possible to devise rations making the maximum use of the food value of silage without any waste.

One of the main points that may arise is the variable moisture content. The figures given are average values, but samples may be drier or wetter than the figures suggest. The wetter samples may give disappointing results unless due allowance is made and the quantities fed are increased accordingly. With a very wet sample it may be necessary to

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increase the amounts by up to one-third, but such samples will be easily detected. Thus a number of low-protein grass silages in which molasses has been added gave lower dry matter values, and 11 lb. would be a better replacement value for 4½ lb. of hay than the 9 lb. suggested above.

When starting to feed silage to all classes of stock, it should be introduced into the ration gradually. No difficulty has been found in feeding up to at least 56 lb. of good silage to dairy cows and proportionate amounts to younger stock. At the Jealott's Hill Experiment Station, up to 70 lb. has been fed throughout the whole winter to a group of cows which milked normally on the ration.

Good silage has other qualities which are of considerable value. In the first place, it is succulent and very palatable, and a useful addition to a ration of hay. This succulence is a point in the favour of silage during a dry year, when grass is short. If silage has been made in the early part of the year when growth is strong, it will be a very useful reserve should there be a mid-season drought.

To return to the actual feeding properties of silage, it is generally a very useful source of mineral matter if the ground has been properly manured. The crop is cut while it is still young and rich in mineral matter, and as it is highly digestible this will be of great value to the animal. With clover and lucerne the calcium content is particularly high. Though it is not necessary with crops from well-manured land, mineral matter can be added in the silo during making.

It is sometimes incorrectly supposed that silage, being acid, may affect animals and cause such troubles as sterility. This is not true, as the acid in good silage is lactic acid, the same acid as is found in sour milk, and is broken up in the animal body to give energy in much the same way as the sugar from which it was formed. There is, therefore, no loss of mineral matter from the body to neutralize the acid, which is harmless to stock and actually has a feeding value.

Another valuable feature of good silage is its vitamin content. In this connexion we need consider only vitamin A or its close relative, carotene, which is formed into the vitamin in the body. This substance is present in quantity in green crops, and is retained in high measure in the silage. It will show in the effect on general condition of stock, and the carotene itself is the cause of the deep yellow colour of milk fat so noticeable in the milk of pasture-fed cows. Silage will

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keep up the yellow colour of milk fat in mid-winter and, with it, its feeding value.

Good silage will not taint milk, if it is used with common sense. It is, for example, necessary to taken any uneaten silage out of the manger to prevent it decomposing, but this should be done with any foodstuff. If a sample of silage has a fairly strong smell, and this may happen in the bottom layers if it has been filled in too quickly, it should be fed out-of-doors. With the pit or clamp it is fairly common to get a silage with the strong smell of butyric acid. This is due to filling too fast and packing too tightly, but the silage will be eaten by all classes of stock, though not so readily as with other types. The chief danger with strong-smelling silage is tainting of milk when it is brought into the shed at milking time, but it is always safer to feed such silage with care and in relatively small amounts. It should not be used for in-lamb ewes or cows heavy in calf. It is only fair to say again at this stage that such silage should be the exception.

Silage can be fed to all classes of cattle, including the youngest animals, to which it affords a valuable source of vitamin A during winter.

Sheep will eat silage freely, and for them it is a very valuable food in winter time and in early spring when grass is often short. Care should be taken with in-lamb ewes, and they should not be fed any bad or mouldy silage.

A ration of 10 lb. of high-quality silage would supply all the needs of a full-grown sheep, but it will seldom be necessary to give such an amount. Two to five pounds per head are often fed, varying with the grass available. It is useful for flushing ewes and for keeping them in milk when keep is short.

For the pig, silage is a useful tonic food and a daily allowance of 2 lb. per day would be ample, though the amount fed to breeding stock may be considerably more, especially when the system includes grazing.

The horse will eat silage, too, but care must be taken not to let it have mouldy material, as this may cause trouble.

Miscellaneous Silages. It may be of interest to consider some silages of less usual character, such as those composed of sugar-beet tops, or steamed potatoes, which may, and should be, used on the farm wherever the original material is likely to go to waste. Some samples of these silages may

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be used for the production ration, but generally they are of most use in the maintenance part of the ration.

		<i>Per 100 lb. of Crop as Fed</i>	
	<i>Dry Matter</i>	<i>Starch Equivalent</i>	<i>Digestible Crude Protein</i>
	<i>lb.</i>	<i>lb.</i>	<i>lb.</i>
Sugar-beet-top silage	25	10.3	1.6
Steamed-potato silage	25	19.8	0.6

The following table of replacement is a useful way of measuring the feeding value:—

4½ lb. hay is equal to :
 13 lb. sugar-beet-top silage,
 or 7 lb. steamed potato silage.

Sugar-beet-top silage is relatively rich in protein, and could at a pinch be used for the production of the first gallon of milk, feeding 26 lb.

It will be seen from what has been said that silage is a very valuable asset on the farm, and will replace hay or concentrated cake mixtures. It is in the second direction that it may be of particular value at the present time, since it will help to tide over any shortage in oilcakes. Generally speaking, hay is the simplest of the roughages to produce on the farm, but here, too, silage is a very valuable alternative process when the weather is unsuitable for making hay.

Of 130 samples of grass silage examined by the writer in the winter of 1938-39, 50 fell into the intermediate class, 35 contained over 16 per cent. of protein (4 were over 20), and 45 had less than 12 per cent. of protein, all in the dry matter. During the present winter, of 58 samples examined to date, 27 were intermediate, 13 had over 16 per cent. of protein, with 2 over 20 per cent., and 18 were cut at a mature stage and contained less than 12 per cent. of protein.

These figures show that the intermediate type of grass silage is commonest. The number of high-quality silages, however, is very encouraging and shows clearly that it is practicable to obtain such concentrated material on the ordinary farm. Every six tons of such silage made will save a ton of dairy cubes.

EXPERIENCES WITH PORTABLE SILOS

J. HUNTER-SMITH,

Hertfordshire Institute of Agriculture

Initial Experience. A portable silo was obtained for trial purposes in the late autumn of 1936. It was erected and filled somewhat hurriedly with luxuriant aftermath rich in clover, and left till March of the following year. By then the full cylinder of green stuff had shrunk into remarkably small space, and there was some curiosity to see what the material would be like; how it would compare with the silage from a tower silo fed during the winter, and whether the cattle would take to it. As it happened, this silage had a more pronounced odour than that made in the tower silo, but it was greedily consumed by the stock and it was pleasant to note how completely every clover plant and leaf had been preserved. The success of this initial experience led to the adoption of the portable silo as a regular supplement to the existing tower silo, and four of them are now in use on the Institute Farm.

The Circumstances on the Farm. Long and short leys are a feature of the farming at the Institute. The long ley of three or four years' duration, on an area which is fenced, provides maximum hay and grazing and the best possible preparation for cereals without dung carting or root growing. The short ley is of one or two years' duration on unfenced land where pigs or poultry are folded and an intensive arable system is practised. The long ley is so grazed that nothing is wasted, but on open land there is often aftermath from part or all of the ley which cannot easily be used, and it is here that the portable silo has proved particularly useful. In addition, an outlying field of lucerne provides a succession of cuts which it is not always easy to make into hay or to cart a long distance to the tower silo. These two rich, succulent crops, which might not be fully utilized in the circumstances on this farm, are stored in portable silos for the winter feeding of cattle.

The Advantages. The initial cost is very small; these silos can be erected near the crop to be ensiled so that haulage is reduced to a minimum; and it may well happen that a silage crop is available on outlying areas or farms adjacent to fields where stock are being out-wintered. Economy effected in these ways is further enhanced by the variety of crops that may be ensiled—specific crops grown for the purpose or incidental flush products which, if not used in this way, would be wasted.

EXPERIENCES WITH PORTABLE SILOS

Crops for Ensiling. Clover leys and lucerne have already been mentioned; the former in a wet autumn are often so luxuriant as to resemble a good cut of hay. But if hay making in September or October is hazardous, there need be no difficulty in converting the luscious product into silage. Any of the cuts of lucerne may be made into excellent hay, provided the weather is favourable, but, even in the best circumstances, dry lucerne hay may have lost much of its leaf and its value before it reaches the stock. This does not happen if the green lucerne goes direct into a portable silo.

As for June grass, without a concentration of stock to consume the spring flush, Nature's bounty at this season becomes a real, if not the main, cause of grassland deterioration. If uncontrolled, the luxuriance of May and June becomes the fibrous straw of late autumn, and tends in later years to develop into a matted type of turf, described as inferior grass land. Here, then, is the opportunity for the mower and the portable silo; areas of grass land (or temporary leys) cut early and ensiled, conserve rich material for winter feeding, help to maintain the quality of the herbage, increase the amount and improve the quality of later grazing, and extend the grazing season.

Obviously, also, it may be better in showery weather to convert hay crops into silage than allow them to deteriorate through repeated leaching with rain. Even lawn mowings from aerodromes, lawns, etc., make rich silage.

Method of Ensiling. The silo is erected on a level site, taking care to carry out the detailed instructions of the makers both in respect of erection and filling. The normal procedure is to fill the silo in sections, allowing intervals of a day or two between each for consolidation. If the crop is short and luscious, it need not be chaffed, but better results are likely to be obtained by chaffing bulky crops containing cereals. It is usual to sprinkle molasses, 20-40 lb. per ton, diluted with two or three times its volume of water, on crops of high protein content (clover, lucerne, tares, etc.), to encourage the lactic type of fermentation which results in the best quality silage. The diluted molasses should be evenly distributed over the material with a watering can or spray pump as it is being filled into the silo, more water being added to the molasses if the crop is on the dry side.

The best results are obtained when the material is neither too wet nor too dry. Excessive wetness may encourage putre-

EXPERIENCES WITH PORTABLE SILOS

faction, but a worse fault is a too-dry condition, which makes it difficult to exclude air and prevent serious loss of weight and value. When filling the silo, the material should be evenly distributed so as to avoid air pockets, and for use the silage should be cut out in blocks, and not skimmed off the surface in layers.

Disadvantages. The chief disadvantage of silage making is the need to handle large quantities of heavy material, and any mechanical aids in loading in the field or at the silo should be introduced wherever possible. Care must also be taken to prevent excessive waste on the outside; with portable silos in which split chestnut or wire netting is used with special types of paper, this is largely a matter of care in carrying out instructions. Waste at the top can be reduced by covering with cavings, straw and soil; one of the most efficient " roofs " is made from large logs or railway sleepers, with corrugated iron sheets to throw off rain water.

The question of waste is important, as one foot of waste round the sides and top would account for about 30 per cent. of the total volume of a silo of 15 ft. diameter.

Quality of Silage. Elsewhere in this issue (pp. 715-721) particulars are given of the quality and feeding value of silage. It is necessary here only to note that portable silos can fulfil the function of preserving succulent food for winter feeding almost as effectively as tower silos. The quality of the resulting silage will depend on the original material from which it is made and on how it is handled. With care in the erection of the silo and in the method of filling it, protein-rich crops of young grass, clover, lucerne, vetches, etc., can be preserved for the winter feeding of cows, cattle and sheep, and to a lesser extent for horses and pigs. Similarly, mixtures of wheat, oats, beans, vetches or peas make excellent silage, especially if chaffed, while a silo also offers a simple way in which to conserve sugar-beet tops and other by-products.

Finally, portable silos of various kinds and sizes, some utilizing a wire frame in conjunction with a bituminous paper, others made of wood, are obtainable in various sizes, costing from about £10 upwards. The assurance can be given that such silos provide a cheap and effective way of preserving many crops and preventing much waste; they can be confidently recommended as a means of augmenting supplies of home-grown, concentrated feeding stuffs.

CLAMP OR PIT SILAGE

THOMAS H. TURNEY

A Big Experiment. During the summer of 1939, my brothers and I made 300-350 tons of young grass into pit silage, and some 50 tons into stack silage. It was a big experiment, but others had done it successfully and so could we. After Christmas, we commenced feeding it to our cows, replacing one-third of the hay ration by three-and-a-half times its weight of silage. The cows liked it and increased their milk yields.

The Tower Silo, Cutter and Blower. Our interest in silage began some 20 years ago, when we first read about Mr. Arthur Amos's work at Cambridge. In those days, before molasses or treacle was used in ensilage, the building of a tower silo was considered necessary. A crop such as oats, tares and beans was usually recommended in this country, and it needed to be "chaffed" and blown to the top of the silo. The relatively coarse crop could not be packed sufficiently closely without "chaffing." At that time, a suitably sized tower silo, cutter and blower would have cost about £500. Fortunately, we were very short of capital, and we were prevented from making this expenditure.

Why were Existing Tower Silos Left Unused? As years went by, we noticed a few tower silos erected in the surrounding district, but almost invariably within a year or so they fell into disuse. We are among those who believe that most farmers are not fools! The disused silos indicated that there was a snag, or snags, somewhere in silage making. Although, in the process of time, our command over capital grew, we still did not put up a tower silo. It was not until the molassed silage from grass, made in cheap silos or in pits, was well demonstrated that our interest in this subject revived.

Silage Making Helps Alternate Husbandry. In the meantime, we had adopted alternate husbandry with long leys as the main feature of our farming. During a growing spring and summer these leys produced superabundant keep, only a portion of which could be grazed. Attempts to make hay from this succulent young growth, full of sap and low in fibre, nearly drove us to despair. It takes a week or ten days even in good weather to make it into hay. The Scotch method of piking may be all right for farmers in the northern districts, so long as they pay no extra wages for overtime: in the midlands and the south, it is both slow and expensive.

Silage Costs Less per Acre than Dried Grass. Grass

CLAMP OR PIT SILAGE

drying was considered, but the chief disadvantage of grass drying is the absurdly low output when the grass is very young and growing rapidly. The high capital cost of the drying plant would not be so serious if the output could be increased some five-fold. Our hopes revived when we found that the young grass from our productive leys could be converted into molassed silage with only a fraction of the expense of grass drying, and with comparatively little wastage.

Getting the Grass from the Field to the Pit. A friend of ours, who can make money at farming more easily than we can, had worked out a good system which we very closely followed. The grass was cut by a mower and elevated by a Cutlift into a trailer cart, where a man levelled the grass and built the load. The Cutlift is an ingenious machine, something like a hayloader, which takes the grass direct from the grass-mower cutter bar and delivers it direct to the trailer cart. This is drawn by a Fordson tractor. Thus the hard work of pitching the heavy grass is overcome, and there is scarcely any waste.

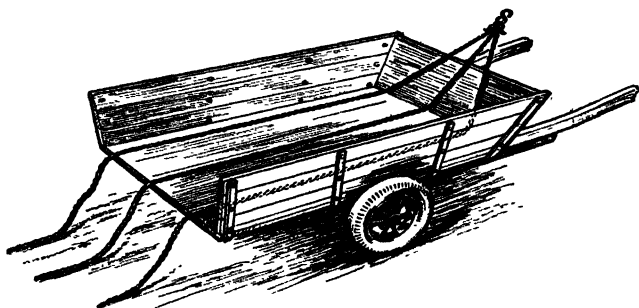


FIG. 1

Preparation for Unloading Grass. Before loading the trailer cart, three heavy cart ropes are laid along the bottom of the cart and brought together to a loose ring or hook that is allowed to hang over the front of the cart (Fig. 1). The loaded trailer cart is taken by another tractor to the pit, where it is backed up and the load pulled off by the same tractor (Fig. 2), using the ropes already laid under the load of grass. By attaching three long ropes to the ends of those at the back and bottom of the cart, the load can be rolled along the pit to any desired spot and there levelled down. By these simple

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methods, the hard work, first of pitching and later of emptying this heavy green material, is eliminated.

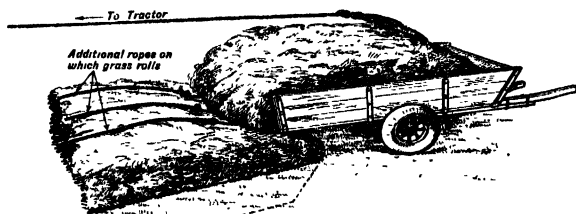


FIG. 2.

Making the Pits. For our pits we chose relatively dry spots to assist drainage, and dug them 2 ft. deep. They were 5 yd. wide and nearly a chain long, and the cost of preparing each was approximately £10. They were made to slope slightly to the centre, and a tile drain was laid centrally along their length. Actually, we had very little seepage from the pits, and the wet weather we had in the following October and November appeared to do no harm. That so much rain should have no serious effect may well have been due to the good natural drainage of the spots chosen for the pits. Another point of some importance is that we bevelled the sides of the pit. Thus, when the grass settled, it compacted, firming on the sides, thereby reducing exterior waste.

Capital Cost. Each pit cost us £10; the Cutlift and mower cost £120; the trailer carts cost £50 each, and at least two are needed. Two tractors, preferably on pneumatics to prevent injury to leys and farm roads, are also needed. Fordson tractors on pneumatics cost £200 each. The capital cost was £650, made up as follows:—

Two pits at £10	£	20
Cutlift and mower	120	
Two trailer carts	100	
Two pneumatic-tyred tractors	400	
Ropes, pulleys, tripod and sundries	10	

The trailer carts can, of course, be used for other farm operations, as also can the two tractors, leaving £150 for silage only. The capital cost may seem high to a farming community that has witnessed nearly 20 years of depression. Nevertheless, capital expenditure which permits more economic working is one of the essentials of progress. We have not

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attempted to work out the exact cost of our silage, but we should say it cost us much more than 10s. per ton, a figure given in some quarters.

The Addition of Molasses. We estimate that our trailer cart holds about one ton of grass, and to this we added at the pit 30-40 lb. of molasses diluted with 3, 4 or 5 times its volume of water. The bigger quantity of water was used in the drier part of the day. About two loads an hour were dealt with, and two men were kept on the pit to spread and tread the grass, and sprinkle the molasses. It is probable that the need of treading young leafy grass full of sap is nothing like so great as with the more usual crops, such as oats, tares and beans, with their coarse, hollow stems.

We continued building on the two pits, working at each one about three days a week, until they were some 12-15 ft. above the ground. They were then covered with soil and they finally sank to a height of 4-5 ft. above the ground. With 2 ft. in the ground, we had 6 ft. depth of silage to cut at. A cubic foot of silage weighs about 40 lb., therefore, each pit will have contained about 106 tons of silage.

Very Little Waste. It is interesting to note that the silage is good right down to the soil at the bottom of the pit, and right to the sides of the pit. There was very little waste under the soil at the top of the pit, but there was more waste along the exposed side above the ground level. Even here the waste amounted to less than 6 in. It has been suggested that if we had covered up the sides also with soil, as is done with mangold pits (for a different reason), there would have been less waste.

On a portion of one pit, in the hope of economizing labour, we covered the pit with corrugated sheets, and weighted the sheets with railway lines. As the pit sank more at the sides than at the middle, this method was not very successful, as there was a certain amount of loss due to most of the weight of the lines being taken over the centre line of the pit. At this point, the silage was good right to the top. When soil is used to cover the pit, it follows the pit down when it sinks more at the sides, which always happened with us.

Advantage of Big Pits. Waste occurs only at the outsides exposed to the air. In a big pit there is a smaller proportion of outside. Those who remember their mathematics will know that the volume of similar solids varies directly as the cube of their lineal dimensions, whereas the surface area varies directly as the square of their lineal dimensions. For example,

CLAMP OR PIT SILAGE

if you have two pits, in one of which the length, breadth and height is three times that of a smaller pit, then the surface area of the larger pit is increased nine times, but its volume is increased 27 times. Actually, the bigger pit would be more solid, and, therefore, contain more weight per cu. ft. Thus, the bigger pit would have only one-third (or perhaps only one-quarter, allowing for the greater density) as much outside surface per cwt. of silage. As the waste is proportionate to the outside exposed area, the percentage of loss is correspondingly reduced in the bigger pit.

Stack Silage. In the autumn of 1939 we had a much smaller acreage that we did not need for grazing, so we dug a circular pit 1 ft. deep and 6 yd. in diameter and built a silage stack on it. For this we used our elevator and built a stack of considerable height. When stacking we had some difficulty in preventing the stack from leaning in the direction of the wind. There was also the added labour of emptying the grass into the elevator. Apart from these two objections, and that there may be more waste at the sides due to a greater surface area being exposed to the air, stacking appears to be an excellent method of silage making. The molasses were added as in the pit silage. If we made stack silage again, we would rather have two or three stacks going at a time, and spend a day building on each in turn, thus giving them time to settle. The stack was finally covered with soil. To get the soil to the top of our stack, bags were tied between the slats of our elevator and buckets full of soil were tipped on to the bags. Thus the soil was elevated to the top of the stack.

No Leaves Lost in Silage Making. What pleases me when I see this silage being used is that all the grass and clover leaves are there. They can be seen. Those who have made hay with tedders, turners and hayloaders know how much leaf can be lost in a dry, hot day. When it is remembered that the young leaf is the highest in protein, lowest in fibre and is the most digestible, it will be realized how serious this loss of leaf in haymaking can be. Another advantage is that good silage can be made from young grass and clover that is difficult to make into hay in our variable climate. There are the further advantages that, in a normal season, silage making could commence by the middle of May; it can be started first thing in the morning and, as long as there is any grass long enough to cut, it can be continued all day and every day almost, regardless of the weather. Those

CLAMP OR PIT SILAGE

who know the annual worries and uncertainties of hay making will appreciate all these very considerable advantages. Covering the pit with soil is heavy work, but I should say it is less expensive than thatching the same amount of grass made into hay. Further, no straw is needed.

Short Leys Give a Greater Output Per Acre. Last year, the material for silage making came from our long leys, but for this purpose, short leys of Italian Rye Grass and Red Clover could be much more productive. They should be ready for cutting at least a fortnight earlier, and for a year or two would produce a greater weight of silage. With silage making in view, we can modify our farming rotation to include short leys as well as long leys and the usual arable crops. Thus, with the flexibility associated with alternate husbandry, and the inclusion of productive short leys for silage, we can maintain our heavy stocking of the land and go ahead with confidence.

THE ENSILAGE OF HAULM FROM A CANNING PEA CROP

N. V. HEWISON,

The College Farm, Wye

For a number of years at Wye College Farm, we have grown peas for canning and sent them to a factory 13 miles away, bringing back the haulm to the farm for ensilage. The by-product is a useful food at any time, but in war, when supplies of feeding stuffs are restricted, it is especially valuable. Growers are responsible for the removal and disposal of this waste from the factories; some spread it on their fields and plough it in; others merely make a dung heap of it; both methods are uneconomic and neglect the rich potential feeding value of this material.

The crop, which, incidentally, has given best results when sown as a first crop on broken-up old pasture, is planted from mid-February to end of April. While green and succulent, the peas are cut with a mower, loaded on to motor lorries and despatched quickly to the factory, where they are threshed, or, as it is termed, "vined." The returning lorries bring back the waste, i.e., the haulm and shelled pods, which are put through the cutter and blown into a tower silo that for-

ENSILAGE OF HAULM FROM A CANNING PEA CROP

tunately already existed on the farm, and if any remains it is placed uncut in a stack silo, as described below.

The pea harvest is spread over about three weeks in July, and 4-5 acres are dealt with in a day, with intervals of 4-5 days between each mowing. This allows ample time for the silage to settle, but not sufficient for it to develop moulds between the fillings. The silage is not treated with molasses; the treading is carefully done and there is practically no waste. The product is sweet and fruity, much relished by stock and has the following analysis:—

Dry matter	..	23.25	per cent.	{	As compared with good meadow hay, of 4.6 per cent. protein equivalent and 37 per cent. starch equivalent.
Protein equivalent	4.7	"	"		
Starch equivalent	15	"	"		

Our stack silo is an extemporary affair—sheep hurdles lined with old corrugated iron—but the product is equal to that made in the tower, although the wastage is higher. The haulm need not be chaffed, as it is well broken in its passage from the viner, but careful treading is essential during the filling. The commercial portable silo should be admirable for dealing with this material, and could be filled straight from the lorry.

Weight of Material per Acre. From the 30 acres devoted to this crop at the College Farm, 60-70 tons, and occasionally more, of silage have been obtained from waste material weighing 6-7 tons per acre. The average weight of shelled peas per acre is 26 cwt.

Feeding the Silage. The silage we make at Wye is used almost exclusively for the dairy herd, and it takes the place of roots and forms part of their maintenance ration. The cows are fed up to 35 lb. each daily, and if there is likely to be a surplus of silage, it is fed to the younger horned stock. The animals take to it readily and, if need be, it may be fed to them three weeks after filling the silo. During frosty weather the silage does not get frozen, unlike roots. It is fed the same day it is taken out of the silo, as on exposure it loses its freshness, and mould may develop, making it distasteful to stock.

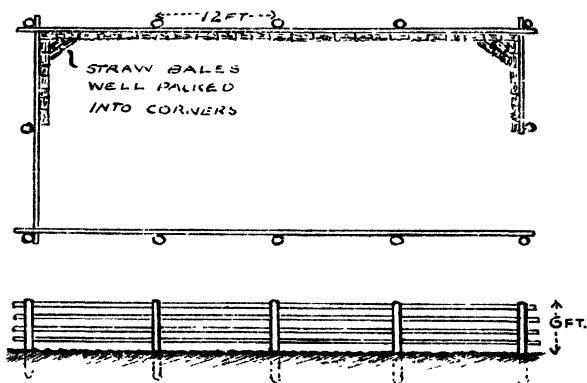
Labour. As the peas must be canned the same day they are cut and the haulm made into silage on the same day, a good supply of labour must be assured. With 4-5 acres a day to be cut, loaded, the waste returned and ensiled, we need to have a least a dozen men on call, and they must be able-bodied men as the material they are dealing with is green and heavy.

A SIMPLE SILO

The search for an efficient, cheap type of silo has gone on for long on the Continent and led to a numerous and wide variety of expedients, but one method used successfully in Bavaria is particularly worthy of consideration at a time when economy and crop conservation are of extreme and immediate importance.

The main feature of this silo is its straw walls. These are built upon a rectangular area, the size of which is dictated by requirements, but which never rises more than 6 ft. in height.

The frame is based on 9-ft. wooden stakes (about 4 × 4 in.) driven 3 ft. into the ground at 12-ft. intervals. Horizontal bars are fixed to the inside of these stakes at 16-in. intervals, and bales of straw (tied with twine, not wire) are closely placed against these to form low walls inside the framework. (Con-



ceivably, bales of rough hay would serve the purpose equally well.) Bales may also be used to floor the silo, but a thick layer of chaff is preferable. The angles at the corners are smoothed off by setting bales crosswise so that no empty spaces or air pockets will be left in the filling process.

Loads of freshly-cut forage are driven in and tightly packed in the silo without any preliminary chaffing. In Bavaria, oxen are used to trample it well down. (In this country a horse might be preferred.) No depressions should be left in the material, and the forage should be kept clean.

The proper consolidation of the silage is the chief factor making for success. If this is adequately done, no other covering beyond a thick layer of chaff is necessary as a protection against rain.

HINTS ON FEEDING

H. E. WOODMAN,

School of Agriculture, Cambridge University

The Outlook for Feeding Stuffs. War can lead to the abrogation of many kinds of law, but not of that known to the scientist as the conservation of energy, which, in ordinary language, implies our inability to produce something from nothing. Yet, during the closing weeks of last year, the stock-feeder might have been pardoned had he inclined to the view that he was being expected to do something approaching this feat. The serious reduction of feeding stuffs supplies experienced over that critical period created a difficult situation all round, but farmers faced it with characteristic fortitude. Now it is all the more pleasant to note a distinct brightening of the horizon in respect of the supply of feeding stuffs for live stock.

It is good news for pig and poultry feeders, for example, that the latest estimate of the wheaten offals position for February, March and April is for a home production of bran and middlings fully equal to that of 1938. The merits of middlings are well understood by the stockfeeder. If only the pig-feeder, for example, is able to secure this feeding product in reasonable supply, he will not need to be told how to use it as a foundation for his rations. Supplemented with moderate amounts of barley and/or maize (see below), with the help, where possible, of cooked potatoes (or soaked beet pulp) and green food-residues, and the addition of some protein food, such as groundnut or bean meal with a small amount of fish meal or blood meal and minerals, the middlings will give him a ration for baconers that will enable him to carry on under more cheerful conditions than have been possible for some time past. But for this, it is essential that distribution should be such that every stockfeeder, both big and small, should be able, without difficulty, to secure his fair share of any supplies of wheaten offals that may be going.

In addition to normal supplies of home-produced bran and middlings, it is anticipated that there will be supplies of imported offals, but well below the 1938 quantities. The percentage of normal releases of imported maize and barley has been increased to 66 per cent. of normal average monthly quantities, and it is hoped to maintain this position at least during February and March.

HINTS ON FEEDING

The order of availability of feeding stuffs for the time being appears to be: wheaten offals; oil cakes (with cotton cake less plentiful than the other kinds); barley and maize. Supplies of home-grown wheat and oats (there is little home-grown feed from barley this year) naturally depend on the rate of threshing and the readiness of growers to sell. It is a curious fact that despite the fairly abundant supplies of wheaten offals, complaints about inability to secure these commodities have been more frequent recently than have been the case with oil cakes. In-so-far as this may have been due to a natural increase in the demand for bran and middlings owing to the *general* limitation of supplies of feeding stuffs, one cannot perhaps grumble.

The By-Products of the Pea-Canning Industry. Large quantities of good winter-keep for sheep and cattle can be made available by the proper utilization of these by-products, which consist of pea-pods coming from the factory, pea haulms plus pods as separated by the factory "viners," and the pea haulms that remain on the field after transport of the pea harvest to the factory or the market.

Recent investigations by the writer and Dr. Evans have shown that pea pods, on the dry matter basis, contain about 15 per cent. of protein, 60 per cent. of carbohydrate (including about 16 per cent. of sugar), 17 per cent. of fibre and 6.5 per cent. of minerals (including 1.5 per cent. of lime). Pea-pod meal, made by artificially drying the fresh pods, was found to be highly digestible. It contained about 55 per cent. of starch equivalent, including 7 per cent. of protein equivalent; that is to say, it was superior in feeding value to the best grades of meadow and leguminous hay. Its high feeding value is evidenced by the fact that an allowance of 14 lb. of dried pea pods plus 5 lb. of medium meadow hay would supply the requirements of a dairy cow for maintenance and the first gallon of milk.

Pea pods should be preserved for winter-feeding in the form of silage. They give an excellent product if they are tightly trampled and a means for draining off the effluent is provided. The silage is of good palatability, pale yellowish-green in colour and having a pleasant vinegary smell with little or no suggestion of the presence of the foul butyric acid. No molasses need be added during filling, since the sugar naturally present in the pods ensures a favourable fermentation. Pea-

HINTS ON FEEDING

pod silage contains about 75 per cent. of moisture, and about 55 lb. would replace the 14 lb. of dried pea pods contained in the specimen ration cited above. It may be fed, in the amounts that are recommended for oat and vetch silage, to all classes of cattle from calves about six months old to dairy cows. It is eaten readily. Farmers delivering peas to the canning factory should arrange, whenever possible, to transport pea pods back to the farm for ensiling in pits or portable silos.

There is a very big acreage of peas grown for picking green for market. The farmer usually attempts to convert the residual haulms into hay, but should the weather be wet, the results are disastrous. It should be emphasized that pea haulms, with or without pods, make good silage when conserved in stacks or in portable silos. One of the best samples of silage the writer has ever fed was made by ensiling pea haulms with pods in a modern portable silo, molasses being added during filling; and at the present time dairy cows are receiving about 35 lb. per head per day of this silage, an allowance which they are eating with evident relish and benefit.

Alkali Treatment of Cereal Straw. The writer has frequently been asked whether the chemical pre-treatment of straw with caustic soda is likely to turn out to be a process that will have any significance for the ordinary farmer. The procedure consists in allowing the chopped straw to soak in a solution of caustic soda of $1\frac{1}{4}$ per cent. strength. As a result of this treatment, the association between the valuable cellulose and the useless substances in which it is embedded, and which prevent its digestion by the animal, is broken down. Thus the treated straw becomes rich in easily-available cellulose, a carbohydrate that, for sheep and cattle, has a feeding value resembling that of starch. The alkaline liquid is drawn off at the end of 24 hours and the residual material is washed with water until free from soda. The resultant wet straw "pulp" is then ready for feeding, and it is claimed that cattle take to it readily.

A study of the available data seems to suggest that an extraction plant, probably costing about £35, will produce, in a 5 months' winter-fattening period, about 8 tons (on the dry basis) of a fodder which contains, as regards wheat straw, rather less starch equivalent (32) than medium meadow hay (37) and, with oat straw, rather more (42). Treated

HINTS ON FEEDING

barley straw lies intermediate between treated oat straw and wheat straw in feeding value. The cost of the water and soda over the season would be about £10. It would be possible to save expenditure on the extraction equipment by using instead two large barrels, each fitted with a wide-bore tap as near the base as possible.

A consideration of the starch equivalents suggests that it is an exaggeration to regard treated straw as anything but a form of roughage. It may best be likened to meadow hay minus the protein, minerals, pigments and vitamins that the hay might contain. Straw pre-treatment would clearly be an insurance against a meagre hay harvest. The great advantage to be expected from the new process is that it converts *wheat* straw, which in its natural condition has a very low starch equivalent and is unsuitable for feeding on account of its hard, brittle nature, into a useful roughage, an important consideration at the present time, when, in consequence of the ploughing-up scheme, there is likely to be an increased amount of wheat straw available. It may be, therefore, that the process will appeal to farmers in the wheat-growing areas of East Anglia, particularly since the most useful application of the treated fodder is likely to be in the feeding of fattening bullocks.

Trials are to be conducted at Sprowston and Cambridge, and it should soon be clear whether the improvement in the feeding value of cereal straw by alkaline treatment is such as to encourage farmers to take a practical interest in the process during the next winter and, what is probably of equal importance, whether it will be feasible to incorporate such a chemical procedure in the routine of the ordinary farm. It may be that the method is one for operation on a factory scale, when a dry product, capable of being stored or transported, would be obtained. Meanwhile, it should be remembered that animals can be induced to eat big amounts of straw by mixing pulped roots with the chopped straw and allowing the moist mass to stand long enough for thorough softening to take place.

Bean Meal. The scarcity of white fish meal has focused attention on the merits of bean meal for supplying an excellent type of protein in the rations of live stock. In consequence, stockfeeders have found it none too easy to purchase beans, farmers fortunate enough to have supplies of this home-grown food desiring to retain them for their own purposes.

HINTS ON FEEDING

Here and there a slight misconception of the rôle of beans (and peas) in the diet is met with. They should be regarded as a compromise between a protein food and a carbohydrate concentrate, since, in addition to their good content of protein, they contain also a liberal amount of starch. Their use as a substitute for protein foods, therefore, enables the amount of cereal in the ration to be cut down. In the feeding of pigs, for example, the use of 25 per cent. of bean meal would replace 10 per cent. of white fish meal plus 15 per cent. of barley meal.

Minerals. When replacing fish meal with bean meal in the foregoing manner, however, the stockfeeder should add 2 per cent. of a mineral mixture to the ration. With the normal pig rations containing cereal and middlings, this need supply only chalk and common salt in the proportions by weight of 3:1. Nowadays, however, when the diet may have to be made up from unusual components, it may be safer to use a mineral mixture containing phosphate as well as lime and chlorine, such as, for example, 1 part of sterilized feeding bone flour, 1 part of finely-ground chalk and $\frac{1}{2}$ part of common salt. There should be little difficulty in providing, during the period of the war, adequate amounts of minerals of the right quality for farm animals.

Silage Policy for Beginners. There will be many newcomers to ensilage during the coming summer, and they will naturally wish to restrict expenditure on the process to the minimum consistent with the production of palatable silage of good feeding value. Such prospective ensilers may be advised as follows: Conserve the ordinary silage crops in pits and clamps. Now is the time to prepare the excavations, before the heavy work of spring begins. Save hay crops threatened with spoiling by rain in the form of stack silage. Reserve any purchased or home-made constructional silo, which should be of the modern inexpensive portable type, for the preservation of specially-valuable crops such as young grass and lucerne.

In this way, the cost of ensiling will be kept as low as possible and the revival of ensilage will not cause an unduly heavy call on the primary war-time materials, such as steel and wood, that are necessary for silo construction. Add molasses during filling whenever possible; indeed, this is essential with young grass if the desired high quality of silage is to be obtained.

HAYMAKING

J. G. STEWART

Whatever progress may be made in grass drying and ensilage, haymaking is likely to continue for some time to be the principal method of conserving grass for winter feeding. Altogether, in England and Wales there are about 25 million acres of farming land. Of these 25 million acres, nearly 18 million acres, or 70 per cent., are in grass, including clover and rotation grasses; and of these 18 million acres of grass, 6 million, or one in every three, are annually cut for hay, representing a total output of about 7 million tons of hay per annum. This calls to mind Jesse Collings's "three acres and a cow," two acres for grazing and one for mowing, an historic example of rough and ready estimation, still very near the mark.

In recent years, the only hay wanted by the trade has been "hard" hay, that is to say, clover or mixtures. "Soft" or meadow hay has been grown chiefly for use at home. It may be wondered whether the lessons of recent research have yet reached the merchants or their clients. Investigation shows that nutritive value lies mainly in leafage. This is intelligible, for a plant which grows erect must, if only to keep standing, become fibrous, indigestible and "hard" before it is normally cut for hay. Whatever the trade may prefer, science seems to be right in claiming that for ordinary farm stock the best hay is that which is well saved from plants cut in the young and leafy stage, whether they be clover, sainfoin, lucerne, mixtures or meadow grasses.

Cutting Young. Feeding quality depends upon a number of factors. Leguminous plants, those of the clover family, are normally somewhat richer in protein and minerals than the grasses, but the main factor affecting quality is the proportion of leaf to stem. Leaves are more tender and nutritious than stems, and leafage is affected by soil and manuring. Poor, dry soils, or soils starved of nitrogen, produce less leaf than moist soils in good heart. The herbage on fields out of heart tends to be stemmy. Ryegrass and dogstail, if present, quickly run to seed: they will show few basal leaves and such as there are will be short. The bottom will remain open until filled up later by clover and such late starters as *agrostis* (bent). Before there is any considerable bulk for cutting, the early stemmy portion will have become "hard," that is to say, fibrous and indigestible. On land in good heart there is a

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general levelling up of productivity and development, and a good bulk fit to cut can be obtained before seed formation begins. At any rate, with mixed herbage maturing at different times, as indeed with all herbage, it is best to err, if at all, on the early side, especially if the weather is fine.

Of course, grass that has been cut in a young state takes longer than more mature herbage to "win" before it can safely be stacked. It may seem dry, but it "comes back" in the evening, and such fodder, if stacked, will probably sweat and mould. On the other hand, if sun-dried so as to become brittle, there will be a considerable loss of leaf in the subsequent handling. Gradual drying, the herbage being shielded from direct sunlight, makes the best hay, and, for that reason, cocking prior to stacking is desirable, the outermost layer protecting the bulk underneath. But cocking is out of fashion, and that man is accounted the most enterprising and efficient who slashes down whole fields at a time, leaves the crop in the swath to take its chance of rain or shine, and when it is thoroughly toasted or leached, sweeps it up to the stack at 20 miles an hour. This is, of course, a rush age! It is magnificent, but is it haymaking?

Proper Cocking. In some years, for example, 1939, this method leaves behind a trail of washed and weathered litter, in some instances apparently not considered worth the cost of picking up for bedding; and, worse than that, it seems to generate an attitude of helpless fatalism instead of the "never say die" outlook which alone befits a man who attempts to run a factory without a roof, exposed to wind and weather. In such circumstances we have to think of methods adopted in countries where seasons like the last are common—the rule rather than the exception.

In the south of England it is, of course, frequently possible to stack hay straight from the windrow, and if the weather is fine long enough, it is not worth while to delay or complicate matters by cocking, not, at least, with grass. It is a rather different matter with lucerne, sainfoin and red clover—plants possessing stoutish stems that do not so quickly dry out as leaves. Such crops should be cut at the very beginning of flowering, cocked up as soon as the clammy feeling disappears, and allowed to dry out in the cocks. This drying out may take only a few days or at most a week of fine, preferably breezy, weather, but, before stacking, the cocks should be turned over to expose the bottoms to sun and wind. In Scotland, no hay

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was ever, or could ever be, stacked otherwise. The hay is shaken, not rolled or pushed, from the windrow into a round pile built gradually from smallish forkfuls, turned over on to the centre so as to keep that high with the hay sloping slightly downwards towards the outer edge or perimeter. The cock is finished to a point and raked out with the fork around the base. Such a cock will settle slowly and evenly, and will generally resist wind and rain. It is all simplicity itself and takes no longer to accomplish than the shapeless, shaggy, split-topped hummocks that too often pass for cocks in many parts of the country. I have been able to get one or two of the younger fellows to make cocks as I think they should be made, but the older men—well, this is the one instance I know where example is not better than precept—they are both equally futile, and one can only pray that fine weather will last.

Cocks can, of course, be swept to the stack. If pitching to carts and wagons is the method of transport, prior cocking reduces the bulk and simplifies collection, so that the process causes little, if any, delay, and it may, of course, be the means of saving a crop that otherwise would be spoiled or ruined.

Conserving Feeding Value. If the foundation of British agriculture is live stock built upon grass land, the superstructure or, at all events, the coping stone to safeguard us through the winter, must be concentrated feeding stuffs. For these we must, in present circumstances, depend very largely upon our arable land and grass. Grass is said to be our greatest national asset. Farmers are now being urged more and more to liquidate that asset from its present frozen condition. Conversion to arable is one way, breaking-up and re-seeding is another. Still another is grass-drying: the idea is sound: it remains to develop it practically and commercially. Artificially dried short leafy grass is equivalent to a concentrate. So far, however, at any one farm centre, it does not seem to have been in very large supply in relation to the output of what is only very well-got hay. It may be doubted whether it will ever pay to instal expensive machinery to dry grass of hay length. If the drying of short leafy grass in quantity, and of reasonably uniform quality, can be shown to be practical and economical, we shall be very much nearer that degree of self sufficiency which is so much desired. That aspect of the matter is now being investigated both on a farm and on a factory scale.

In the meantime, individual farmers not too well endowed,

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perhaps, with ducats might be trying other and simpler means of attaining a similar end. In this connexion, ensilage is already dealt with in this issue. As regards hay, for the attainment of high quality the most promising method is the tripod in its improved form of collapsible legs with movable vents. The whole outfit costs only a few shillings and each tripod will take about 5 or 6 cwt. There is no doubt that, 12-24 hours after cutting, turning or tedding, grass can be dried on these tripods to preserve the original green colour, and, I should imagine most or all of the other special properties said to belong to artificially dried grass. A near approach to the same thing can be made by ordinary cocking so long as the weather remains fine up to at least completion of cocking. Anybody with sufficient barn accommodation to allow the emptying of one load of partially dry hay into each bay in turn, so that, at the end of the day, no bay contains more than two loads, can also provide himself with a supply of green hay. On a hot day, the temperature under a roof of corrugated iron exposed to the sun is almost unbearable. At night the wind carries on the good work.

Shutting Up the Fields in Sequence. Most people prefer to start mowing on the early side, if only because they know that by the time they finish, some of the hay area will be over-ripe. One way to deal with several fields in, approximately, proper sequence, is to shut them up at different times. A flock of breeding ewes is a great help in this connexion. As the grass grows in spring, the needs of the flock, augmented by a lusty family of growing lambs, increase correspondingly, with the result that the last field may not be shut up till about the middle of June. Indeed, where wild white clover seed is to be harvested, shutting up at mid-June is just about the right time.

Spreading mowing over the season in this way—no inconvenience to farmers whose chief crop is grass—has the further advantage that fields need not be cut at the same time each year. Early cutting keeps some kinds of weeds in check, e.g., brome grass and yellow rattle; late cutting checks agrostis and creeping thistles.

Stacking. A word about stacking. If the hay is in really first-class order, the larger the stack, perhaps, the better; the smaller man less well equipped with stacking tackle will generally find that a 10-ton stack is big enough. That is, 15 tons in and 10 tons out. It is desirable not to exceed 4 yd. in width: the narrower the stack, the less the risk of over-

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heating. It is no less important that the stack should be properly built. If, when cutting out you find that the hay on the outsides is sloping downwards and outwards, you are not surprised that water has failed to enter. This means keeping the heart high and the outer edges well trodden. For such a stack, thatching is a minor consideration provided the roof is well raked down and out after settling. It is sometimes thought that thatching is a very necessary function, yet in wet northern climates some farmers never thatch at all. They throw a discarded herring-net over the top. Is there some magic in a covering that is all holes? Not a bit: its effect is purely secondary. First of all, the stack has been properly built, the roof has been well raked down, and the net keeps the "thatch" in position.

There is another form of thatch that will answer fairly well during the 4 or 6 months the stack stands in the field. It consists of a special oiled paper supplied in rolls a yard or more wide. The paper is arranged over the roof of an oblong stack in overlapping widths and is held down by rolling the ends over fairly heavy wooden poles. The fixing requires some care so that wind does not get under the laps or cause undue friction anywhere. The danger is tearing. A somewhat tougher paper than that now sold for this purpose is really needed.

It is difficult to build a stack that will keep out water, thatch or no thatch, if labour is short and the work is hurriedly done. The best results are obtained when building extends over several days and the stack is well hearted up and, of course, sheeted every night if the weather is not to be trusted. One certain way of ensuring that the sides will sink lower than the middle is to build the stack over a central vent. For the last stack of all, usually the one that needs ventilation most, the tripods already mentioned, a whole string of them, may be used. They should be connected up by a wire stretched along the top.

To summarize: if you want to cut green hay from a stack, first cock it, using tripods if necessary, then build into a stack no more than 12 ft. wide with a vent throughout its entire length. Another way is by slowly filling a Dutch Barn so that each layer of one or two loads, per bay, is allowed a day or two for further drying. To all but the "small man" this will seem too slow. After all, however, it is no slower or more gradual than ensiling is, or should be, and it is a good deal less laborious. In unsettled weather, it is the quickest and, indeed, the only way to make hay at all.

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Still Time to Raise the Yield. Hay occupies a greater acreage than any other crop. No other crop offers such scope for improvement both of quality and yield. Ways of improving quality have been suggested. To raise the yield, the readiest and surest means is the use of artificial fertilizers. A good crop this year may be of inestimable value. It is not yet too late to try for it. In general, the most manurial dressing would be:—

1 cwt. sulphate of ammonia	..	} per acre.
2 „ superphosphate	..	
1 „ Potash salts (30 per cent)	..	

MODERN HAYMAKING MACHINERY

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In the next year or two, the hay crop must inevitably assume an even greater importance than hitherto. From a reduced grassland acreage we must produce more winter food than ever before; and this in the face of a possible shortage of labour. As far as labour is concerned, greater general use must be made of all the developments which on many farms have already made haymaking one of the most highly mechanized of field operations.

Cutting. Recent progress has been in the adaptation of horse-drawn implements to mechanical power, and started when ordinary mowing machines were first coupled behind tractors. This practice—which, incidentally, was very bad for the mowing machine—saved little labour, but, by giving a higher cutting speed, and by avoiding the limitations imposed by tired horses, started a whole series of changes in the hay-making time-table.

For the same purpose to-day, a wide range of equipment is available: the specially designed tractor-trailer mower; the power take-off mower or mowing attachment; and the one-horse mower with an auxiliary engine—to say nothing of the self-contained motor-mowers which a great many farmers have contrived for themselves with the aid of the village blacksmith. For sheer speed of cutting, there is nothing to equal the wide cutter bar of a power-driven mowing attachment, or, where this device is not adaptable to the particular tractor concerned, a power take-off mower. Now that wider following implements have been introduced, there is no longer any great

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difficulty in dealing with the wide swath left by these power mowers, and with their aid even a low-powered tractor can cut 25 acres a day. Power mowers are expensive both in cost and maintenance, however, and the present tendency is once more towards the trailer type. Modern mowers of this kind are very different from the converted horse machines once used; they are specially built for continuous high-speed working; most of them have forced lubrication; and their controls are placed so that the tractor driver can operate them without great difficulty. One of the latest models is fitted with a self-lift device which saves both time and fatigue.

The one-horse mower with an engine-driven cutter bar is less commonly used than any of the above, but there is much to be said for its wider application in war time; it allows one indifferent horse to do appreciably more in a day than two good horses with an ordinary machine would do; and it is economical in fuel.

Carrying. Where the hay can be stacked or baled in the field, the motor or tractor sweep offers easily the most rapid means of collection that has yet been devised. The high-lift stacker, which was introduced when motor sweeps first came into fashion, is hardly ever seen nowadays, but the low-trough elevator can keep two sweeps busy and will make a better stack. Most people who have used them would prefer motor-cars to tractors for pushing the sweep, at any rate on level fields; but when the higher fuel cost is taken into account the advantage of the car is not great, and if the tractor is not wanted elsewhere it might as well be used for this purpose. Some people seem to be able to use high-speed motor sweeps even across ridge-and-furrow, but this is an uncertain business at the best of times, and one of the tractor sweeps that can be lifted when it has picked up its load is a better all-round proposition. Where the hay has to be taken to a stack-yard, so that sweeps are out of the question, the hayloader is widely used—with a tractor if more than one is available, or with horses if circumstances make it better to use the tractor for taking the wagon home. Here, as at the beginning of hay-making, pneumatic tyres are invaluable—on the tractor, on the wagon or trailer, and on the power mower—and the less mechanized the equipment in other directions, the greater their relative advantage.

Making. Changes in the equipment for the actual making processes have been less striking. For a long period it seemed

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as if 4 ft. 6 in. was the only width of swath to which machines could be adapted, with attendant difficulties in the use of wide-cut mowers, but side rakes and swath turners capable of dealing with wider swaths are now available. One machine handles two 6 ft. swaths—either turning them separately or putting them together for sweeping—while a neatly articulated frame allows it to be used on ridge-and-furrow or to be taken through narrow gateways without trouble. Stronger tip-rakes suitable for high-speed work behind tractor or motor car have also been introduced.

Improvement of Hay Quality. Even when ample labour was available, old-style haymaking was badly balanced in its time schedule, for, by comparison with the rate at which "making" might proceed in favourable weather, cutting was a slow business, while carrying and stacking were not much faster. In a doubtful season, grass was quite often deliberately cut in wet weather (so that no part of any subsequent spell of fine weather might be wasted in the haymaking process), although this generally meant reducing the chances of making good hay. Again, the good results of well-timed cutting and quick making were only too often spoilt because the hay could not be gathered and put out of harm's way quickly enough. To-day, the whole time-table has altered: with high-speed cutting, the need for starting in the rain rarely arises and the whole job of making is made easier from the start; while with faster methods of collection the final stages are much less hazardous.

Rapid Drying. For further progress we must look to the elimination of losses in the making process. Recent work on grass-drying in the field has stressed the fact that the best hay is that for which the interval between cutting and carrying is shortest, and has explored the possibility of accelerating drying by the appropriate use of existing implements. For the weather is not the only source of loss: there is a continuous loss of food value through respiration while hay is lying out.

No research of this kind can lead to results applicable in all circumstances, since so much depends both on the type of material to be dealt with and on the prevailing weather conditions. The results do, however, indicate that a considerable measure of control is possible by the proper use of implements. In one experiment with meadow hay, for example, the overall time required in favourable weather to dry the material sufficiently for carrying was very much reduced by tedding immediately after mowing. In other

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words, while the air humidity was low enough for drying to take place, there was advantage in exposing the maximum possible surface area to drying action. On the same occasion, the overall drying time was still further reduced by putting the tedded hay into windrows overnight, because the air humidity was then so high that reabsorption of moisture—not drying—was taking place.

Altogether, the difference between the best and the worst treatments in this particular experiment meant the difference between having the hay in the rick in good condition at the end of the second day after cutting, and having it still in the field at the end of the fourth day. Perhaps the most significant feature was that the so-called worst treatment was not very different from the common practice of the district. This and similar experiments suggest that, with meadow hay at any rate, there will often be advantage in tedding at the earliest possible moment after cutting; and in leaving it tedded for just as long as there is no risk of reabsorption. It should be borne in mind, however, that particularly during the later stages of drying, the air humidity may be high enough to cause reabsorption of moisture for the greater part of the day, even when the weather is reasonably fine. With seeds hay, on the other hand, tedding may be less desirable since the swath as cut very often lies high enough to allow free passage of air underneath.

HAY BALING IN THE FIELD: RECENT EXPERIMENTS

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Field baling was first studied several years ago with the object of finding a method of utilizing sweeps on farms where it was desired to stack at the homestead; and a description of the two main types of machines—ram balers making high density, wire-tied bales, and press balers making low density, twine-tied bales—appeared in this JOURNAL in May, 1938. The system has become increasingly popular in America, where the advantages claimed are reduced losses in storage and convenience of transport in the winter.

It is still considered in America that hay for baling should be somewhat drier than for stacking, but experiments in the south of England have shown that moisture content alone is

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not the main factor. Loss of feeding value, indicated by dustiness and patches of mould inside the bales, was found to be associated with a too slow loss of moisture from the bales, and a comparatively high temperature inside the bale. Eventually it was found possible to bale hay at a moisture well above that considered safe for stacking, at a bale density which allowed the moisture to escape before excessive and prolonged heating could occur. As pointed out later, attention must be paid to the way in which the bales are stored.

The nutritive value of hay falls with increased exposure to sun and rain, while any extra turning in the latter stages of drying results in a considerable loss of the valuable leaf; consequently, hay baled in the field can be of higher nutritive value than stack hay. If the baling technique is correct, this higher value is maintained in the bale.

Bale Storage. Bales from both types of machine should be picked from the field each day and stacked (preferably in a barn) with the stack clear of the ground on timbers.

Stacks of wire-tied bales should have gaps of 3-4 in. between the rows, with the rows in adjoining layers arranged to run at right angles. The bales should be stacked on their narrow sides to minimize surface contact, and with the rough top edge to the smooth bottom edge to allow air movement.

With twine-tied bales, it is better not to attempt to leave gaps: ventilation is better than in a stack, but much less than obtained with wire-tied bales.

In a well ventilated stack of wire-tied bales, moisture is expelled quickest when the temperature nears its maximum—usually after 3-4 days. With a not excessively tight bale, this heating period lasts only a few days, during which ventilation is all important. Cold, damp atmospheric conditions are apt to cause condensation and the formation of outside mould where ventilation is deficient. The 1939 season was favourable for mould formation, but in spite of the abnormally high moisture content of some bales the bulk kept remarkably well. It has been found that the loss in moisture is very slow after the temperature has reached normal, but there is a very gradual loss over a period of several months before a stable condition is reached. This period is found to be more extended with seeds hay than with meadow hay, probably because the fleshy clover stems give up moisture more slowly. Twine-tied bales behave in a manner intermediate between wire-tied bales and an ordinary stack.

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Experiments on Baling Technique. Bales from both types of baler were produced, with moisture contents and bale densities varying from well above the highest accepted limits to the lowest obtainable in practice. Representative bales were stacked separately and examined daily for temperature and loss in weight. The bulk were stored undisturbed, according to normal farm practice described above, and kept for comparison. After reaching a stable condition, all the observed bales were sampled and tested for moisture content, carotene, and some for digestible protein. In addition, about 30 representative bales were opened and judged by a panel of experts.

Although the full experimental data are not yet completed, an account of some of the results may be of interest.

Moisture Content. As a result of earlier work, the following tentative relation between moisture content and the safe bale density for wire-tied bales was offered:—

$$D = 30 - \frac{2}{3} M.$$

where D = Safe bale density in lb per cu. ft.
 M = Moisture content per cent.

Bale density is, of course, an average density, and it is important that it should be as uniform as possible throughout the bale. The baler should be fed, therefore, as evenly as possible. When a bale in an experimental series did not behave as might be expected, it was usually found to have been unevenly packed.

As the cross section of a bale is fixed, it is necessary only to know the length and weight to obtain the density. With a little practice it becomes possible to judge the moisture content of hay and so decide when it is fit to bale.

It is now possible to set a given baler so as to give a density within the limits necessary to avoid damage through overheating.

<i>Bale Density</i> (lb./cu. ft.)			<i>Maximum Temperatures ° F.</i> <i>reached during storage</i>		
			<i>25 per cent.</i> <i>moisture</i>	<i>29 per cent.</i> <i>moisture</i>	<i>35 per cent.</i> <i>moisture</i>
9.0	..	..	—	84	—
10.0	..	..	79	87	87
11.0	80	83	—
12.0	83	92	110
14.0	81	84	113
14.5	88	105	117
15.5	95	110	130
17.5	90	—	133
21.5	—	—	136

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The figures above give the densities at the time of baling and the maximum temperatures reached during storage for various wire-tied bales of seeds hay, baled at three different moisture contents.

If the formula for critical densities is applied to these three different moisture contents, it is found that the highest permissible densities are 14.0, 11.0 and 10.0 lb. per cu. ft. In each, such a density does not allow the temperature to rise far above 80°F.

Bales of meadow hay, very different in composition from seeds hay, gave figures very close to these.

Past experiments and the judging of the 1939 bales confirm the contention that temperatures above 90°F. are associated with inferior quality. The hay was judged according to general appearance, smell, feel and colour, and it was found that, whatever the initial moisture content of the material and whether it was seeds or meadow hay, every bale that had reached a temperature of over 90°F. was placed in a lower class.

The undisturbed wire-tied bales were quite comparable with the observed ones, but with the press bales there is little relation between the observed bales in a small stack and the undisturbed bales in the larger stack. Whatever the density of a press bale at the time of baling, it is subsequently increased to something approaching that inside a stack by the weight of bales above it. In practice it is found that twine-tied bales can be made at moisture content up to 30 per cent. without deterioration, provided the stack is built on timbers.

Carotene Content. Temperatures slightly in excess of 80°F. cause a loss roughly in proportion to the excess temperature. Seeds hay sampled in the field at 35 per cent. moisture content is found to have a carotene value of 100 to 150 mgms. per kilo. Bales which did not heat above 80°F. had a carotene content of 120 mgms. per kilo. after six months' storage. Where the temperature had reached 90°F. the carotene content was only 90 mgms. per kilo., and fell to as low as 35 mgms. per kilo. in bales which had heated to temperatures over 120°F.

The carotene value for press bales from the main stack was lower than that of the corresponding observed bales because of the greater temperatures reached in the stack. Generally the carotene content is a little higher than would be expected from an ordinary stack made of the same material. Meadow hay

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gives similar results to those obtained with seeds hay and carotene contents as high as 150 mgms. per kilo. were obtained from hay baled at about 30 per cent. moisture.

Although the bale density should not exceed the safe limit beyond which overheating occurs, experiments this year indicated that a bale can be made too loose, when a considerable loss of carotene takes place through the increased exposure to light and air.

Baling in Wet Districts. Most of the experiments have been conducted in the south of England, but the weather during the 1939 experiments was almost as unfavourable for hay-making as anything that might normally be expected in the north and west. There were 14 rainy days out of 35, giving a total rainfall of $1\frac{1}{2}$ in., and often the days were dull, damp, and well below the average temperature for the time of the year.

Many samples of hay were taken in Northumberland at various stages of the hay harvest, and were examined for moisture content. In these regions, because of the difficulties attending the last stage of drying out prior to stacking, the best hay is made by leaving it on the ground only for so long as is sufficient to reduce the moisture content to a level safe for building into carefully made pikes. At such a stage the hay is said to be "saved," and it remains in the pikes until the moisture content has fallen to a level safe for stacking. A typical field of meadow hay cut at 80 per cent. moisture, dried out in the field to 25 per cent. in about 5 days, and was then piked.

In ten different fields, meadow hay was piked at moistures varying from 23.8 to 32.6 per cent. and seeds hay from 22.5 to 40.8 per cent. The hay remained in these pikes for at least three weeks, at the end of which time it had dried to between 20 and 22 per cent. moisture and was safe for stacking.

Practically all this hay could have been successfully baled at the time it was piked.

Conclusions. These experiments show that hay may safely be baled some days before it is dry enough to stack. Baling, therefore, not only saves time but also reduces the risk of loss due to bad weather. In the wetter districts of the north and west it may even be possible to dispense with the final curing stage which takes place in the pike.

COMPOSTS

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Composts in the Old Days. Composts were formerly much used in British farm and garden practice, and the art of making them was well developed in the middle of the last century when labour was cheap and abundant, and prices of farm produce relatively high. J. Hannan, of Kirk Deighton, Wetherby, Yorkshire, a well-known farmer-writer of those times, describes in Morton's *Cyclopedia of Agriculture* how they should be made. Three kinds were recognized: farmyard manure composts, lime composts and earth composts. The farmyard manure composts were made by building up alternate layers of farmyard manure and of vegetable waste, each about one foot thick: the surface of the heap was then covered with earth. After the mass had undergone decomposition, the heap was turned and well mixed, then remade and again covered with earth or ashes. The vegetable waste could consist of sods, peat or turf, leaves, heath, moss, rushes, weeds, hedge clippings, seaweed, etc.

Another method used where no farmyard manure was available consisted in making the heap of vegetable waste only, and watering it with liquid manure: he instances a farm where the couch grass gathered from the fallows, and the harrowings of weedy stubbles, especially of beans and peas, gave by this method 200 cart loads of good compost in one summer: a testimony to the profitable use of liquid manure and the weediness of the farm.

Special attention was devoted to the composting of peat in Scotland and Ireland. The peat was left to dry for a few months, then made into a heap of alternate layers, the peat layer being 6 in. thick and the dung 10 in., then peat 6 in. and dung 4 in. and so on. The dung should be fairly fresh, but the heap required watching to see that it did not get overheated and "fire fanged": in that event it had to be watered.

Alternatively, lime was used instead of farmyard manure, but much less was needed; one measure of lime was recommended for five of peat, but for other vegetable wastes the amounts were not specified.

Earth alone, or soaked with urine or liquid manure, was also used.

The making of compost heaps involved a good deal of labour and it gradually went out of use with the shift towards

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grass instead of arable, the rising cost of wages, and the fall of prices.

Many gardeners, however, continued to compost their vegetable wastes, making up the heap and in some cases watering it with household slops which were found to facilitate the rotting.

Modern Methods of Composting. (A) **INORGANIC ACCELERATORS.** The subject was put on to a proper scientific basis in 1921,¹ by H. B. Hutchinson and E. H. Richards, who showed that the decomposition of the organic matter in the vegetable wastes (which is the basis of compost making) depended on an adequate supply of air, moisture and food for the organisms that bring it about, and the avoidance of acidity that would hamper their activities. The most favourable temperature is about 100°F.-120°F., but this develops by itself if the other conditions are satisfied: the temperature may rise to 150°F. without harm, but water should be added to make good the loss by evaporation.

For straw containing 0.5 per cent. of nitrogen, they found it necessary to add another 0.72 per cent. If more was added it was wasted, but if less, decomposition was greatly retarded. The source of nitrogen could be animal excretions, notably urine, as in making farmyard manure, or, alternatively, sulphate of ammonia, cyanamide, or similar quick-acting material: where sulphate of ammonia was used, some $\frac{3}{4}$ cwt., together with 1 cwt. finely-divided carbonate of lime, sufficed to treat one ton of straw. Cyanamide did not require additional lime. Phosphate might also be needed.

The practical difficulty of rotting straw on the large scale is to get it wet; when this is done and the nitrogen compound added, decomposition proceeds quickly, giving a well-rotted manure.

About 40 per cent. of the original organic matter is lost, but the loss falls entirely on the carbonaceous part and none on the nitrogen. Even when exposed to rain, the compost loses only little nitrogen, in contrast with farmyard manure, which may lose 30 or 40 per cent. Potash is liable to be lost, but not phosphate. In view of these low losses, it is unnecessary to protect the heaps against rain; on the contrary, they should be exposed and flat-topped so that the rain water can soak in and provide more moisture for the organisms. When the work is properly done, 1 ton of straw can make 3 tons of compost; during the process it requires about 800 gal. of water

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and from $\frac{3}{4}$ to $1\frac{1}{2}$ cwt. of the chemical food, according to its composition.

In order to ensure that the discovery should not be improperly exploited, a patent was taken out and worked by a non-profit-making syndicate, the moving spirit of which was the Earl of Iveagh. Steps were immediately taken to examine large numbers of vegetable wastes; their nitrogen requirement was determined and direct tests were made to see if decomposition proceeded normally with each one.

The nature of the carbohydrate constituents plays an important part in the decomposition, and hard lignin-like material has to be balanced by the addition of softer cellulosic material such as leaves, grass, etc.

In general, however, it is not recommended that woody substances, such as hedge trimmings, prunings, etc., should be composted; they are better burnt.

The heap is made in a shallow pit dug about 2 ft. deep, but the excavated soil is put round the sides so that the actual depth becomes much greater. The vegetable waste, while still fresh, is laid in a layer of about 6 in. and wetted if necessary: the chemical is then added at the rate of 1 part to 20 of dry matter of the waste, which works out to about 2 lb. per large barrow load. New layers are then added till the heap is sufficiently high: it is then left for 2-6 months, during which time, however, it should be turned at least once, otherwise the top layer remains undecomposed. Sufficient heat is generated to kill seeds of annual weeds, but one cannot be sure of destroying fresh roots of bindweeds, couch grass, dock and similar resistant weeds: these are better burnt.

Grass cuttings should be mixed with about 10 per cent. of straw so as to ensure a more even type of decomposition.

Good composts made from garden rubbish may contain as much nitrogen as farmyard manure, and more phosphoric acid and potash. The averages of E. H. Richard's samples were:—

	PERCENTAGE COMPOSITION				
	<i>Dry Matter</i>	<i>Organic Matter</i>	<i>Nitrogen (N)</i>	<i>Phosphoric Acid (P₂O₅)</i>	<i>Potash (K₂O)</i>
Compost from garden rubbish	29.3	13.0	0.66	0.60	1.12
Ordinary farmyard manure	23.9	18.9	0.53	0.23	0.56

Much work has been done on the subject at the Cheshunt Experiment Station under Dr. Bewley. Straw decomposed

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by 3½ months' composting by the Adco method proved as useful as the long horse manure favoured by glasshouse growers.

Many thousands of tons of compost have been made by this method, especially by nurserymen and market gardeners in Great Britain and by planters overseas.

Other methods of supplying the food for the organisms are used. Dr. M. A. H. Tincker informs me that at Wisley compost is made from all garden rubbish, including oak and chestnut leaves from the common, woody twigs from Hornbeam hedges, etc. The heaps are about 22 yd. × 4 yd. × 5½ ft: the "starter" used is sulphate of ammonia and a little powdered chalk: and the heaps are watered with a garden hose. The time required depends on the proportion of soft grass clippings: if this is adequate, six months in winter is usually long enough for the making of a good manure.

Pine needles should not, however, get into the heap; they are liable to diminish the value of the compost.

(B) FARMYARD MANURE AS ACCELERATOR. Where farmyard manure is available, it can be used as in the old days for composting. On the Continent, a modification of Kranz's so-called hot fermentation method (designed for making high-grade dung) has been used. The vegetable waste is mixed with dung to form the foundation layer of the heap: daily additions go in turn to quarters of the heap, each lot being left loose and open until it becomes hot; it is then trampled down. Four such layers are made, each of them in the first instance 2-3 ft. thick. Each is trodden down and moistened uniformly with dilute liquid manure. During the first or aerobic decomposition, the temperature rises sufficiently to kill weed seeds: after it is compacted, anaerobic decomposition continues. The final heap is about 10 ft. high, and is covered with earth and left for 3 to 5 months.

At Cheshunt, good results have been obtained by a much simpler method: compost is made of thin layers of horse manure sandwiched between thicker layers of straw. Composting is not even necessary: straw can be sprinkled with sulphate of ammonia or a complete fertilizer, and put straight into the soil; in farming practice, ploughed down.

(C) EASILY DECOMPOSABLE VEGETABLE MATTER AS ACCELERATOR. *The First Indore Process.* Composts are particularly important in those tropical countries where farmyard manure is used as fuel and where, therefore, other methods of manuring the land have to be adopted.

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India is a notable example, and Hutchinson and Richard's work proved of great importance there. The particular sources of nitrogen used in England were not very suitable, but alternative sources were found. In the so-called Indore method devised by Sir A. Howard the source of nitrogen is young vegetable matter containing more nitrogen than is needed for its own decomposition, and, therefore, with nitrogen to spare for decomposition of material inadequately supplied. The difficulty about water supply is minimized by putting earth into the heap; this holds water and so ensures a reserve that prevents the heap drying out. In parts of India it is possible to obtain earth from cattle stables, and the urine supplies nitrogen for facilitating decomposition.³

(D) HABITATION WASTES AS ACCELERATOR. Yet another method, also from Indore, was worked out by F. Keith Jackson and Y. D. Wad, where habitation wastes and human excreta and the ordure that otherwise lies about the streets of an Indian village were used. This furnishes nitrogen for the decomposition and has the advantage of encouraging public cleansing of the villages: even if the material had little fertilizer value the process would still be worth while for the sake of keeping the village clean.

Dr. Gilbert Fowler has also worked out a method using habitation wastes and human excreta. Others have been studied at Bangalore.³ Methods of this type are of obvious importance in places where there is no water-borne sewage system, and where, therefore, excrementitious material is available.

Materials Used for Composting on the Farm. In gardens, nurseries and market gardens where no animals are kept, there is a supply of material of various kinds for composting, but on most English farms there is generally very little that in practice can be composted. Such things as sods, weeds, leaves, moss, etc., do not usually occur in sufficient quantity to make composting possible. Leaves of mangolds are far more conveniently ploughed in, so also are green manure crops; sugar-beet tops are better fed to animals and hedge trimmings must in any event be burnt. Potato haulms are a possibility and, as shown later, there is no clear evidence that diseases survive composting. In some districts, however, peat can be obtained.

PEAT FOR COMPOSTING. Peat has proved useful as material for composting. In horticultural work, its value is well estab-

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lished and before the war a good deal was imported into this country from Germany and used for this purpose. Methods of making composts for potting have been described by Lawrence and Newell of the John Innes Horticultural Institute.⁴ Experiments on the making of peat composts for manure on an agricultural scale are being made by the Macaulay Institute in Lewis, thus reviving an old Scottish practice: good results were obtained from a mixture of 10 tons peat, 1 ton farmyard manure, 5 cwt. basic slag and 2 cwt. 30 per cent. potash salt. Considerable heat is developed, and after some months the material breaks down to a dark brown, dry, friable mould which makes an excellent manure.⁵ The investigations are still proceeding, but it appears that sphagnum peats take longer to compost than *Eriophorum* (Cotton grass) peats, and these longer than fen peat.

WASTE STRAW FOR COMPOSTING. The commonest waste materials are those thrown out from the threshing machine, and straw in excess of animal requirements and not saleable or otherwise usable. Threshing waste, however, contains many weed seeds, and farmers are rightly nervous about using it as a source of manure, hence it is usually burnt. This is certainly the safest and, in present circumstances, probably the best procedure.

We are finally left with waste straw (i.e., straw which cannot be made into farmyard manure by the animals) as the only practicable material that can be composted, but this constitutes a really difficult problem which, on the farm, has not yet been solved in spite of many efforts at Rothamsted during the past seven years. The first difficulty is to wet the straw uniformly, and short of putting it into a tank of water or passing the straw through a special machine that cuts the straw, waters it, and adds the accelerator, no satisfactory way of doing this has been found. Samples made at Rothamsted by setting up the heap, watering from the water cart and the rain, yielded poor material containing 0.3-0.45 per cent. of nitrogen, 0.25-0.35 per cent. of phosphoric acid (P_2O_5) and 0.16-0.3 per cent. potash (K_2O), which gave definitely poorer results than farmyard manure. Attempts have been made to dilute farmyard manure with straw: these are still going on, but as yet with little promise of success. In an experiment with potatoes, dung (15 tons per acre) alone was compared with dung (the same-sized dressing) *plus* 2 tons chopped straw. The addition of the straw was of no visible advantage:

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indeed, there was a slight but not significant depression in yield of the potatoes and no significant benefit to the succeeding oat and clover crops.

A very ingenious method of composting straw was devised by E. H. Richards and put into operation at the Wainfleet camp during the 1914-18 war. The straw was set up in the form of a filter in three sections over which the sewage from the camp was passed. The micro-organisms multiplied rapidly and absorbed the nitrogen, decomposing the straw and producing a good manure rich in nitrogen, and at the same time purifying the sewage and converting it into a harmless effluent.⁶ The method was tested at a Land Settlement and gave very promising results: it might be desirable to revive it. So far, the simplest way of dealing with excess straw is to put it on the land in winter or early spring, add a dressing of cyanamide or sulphate of ammonia as accelerator, and plough it in, leaving it to rot in the soil.

Do Plant Diseases Survive in Composts? It is not possible to state definitely whether plant diseases are, or are not, likely to be spread through diseased material that may have got into the compost heap. No direct experiments have been done on the subject. Bewley found that tomato stems and leaves carrying spores of *Verticillium* disease were dangerous in the compost heap and badly infected the next crop. On the other hand, there is no evidence that the spores of ordinary blight (*Phytophthora infestans*) would survive composting of potato haulm, though Wart Disease and Pink Rot might do so. In gardens it is impossible to avoid diseases completely, and while certain of them, such as virus diseases and others, would not be likely to survive the composting process, others caused by organisms producing highly resistant spores might do so. Possibly Finger and Toe would survive: it is known that its spores remain viable when passed in the dung of cattle and sheep.⁷

Evidence of the Value of Compost. In view of the great amount that has been talked and written about composts, there has been surprisingly little field experimental work on the subject. There is little doubt that well-made compost has considerable fertilizer value, but actual figures are almost entirely lacking, and therefore no comparisons with artificial fertilizers or farmyard manure are possible, nor are figures of cost under English farm conditions available.

A good deal of compost has been made on tea estates in

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North India, where the necessary vegetable matter is easily collected from the uncultivated land near the estates. The collection of this material has, however, in places led to bad soil erosion.

It is stated that the results are best when sufficient quantities of cattle or other animal manure are available; they are said to be less satisfactory where the animal material has been deficient.⁸ Attempts to run the tea estates on compost alone, however, proved unsatisfactory: it was necessary to provide the proper artificials.

There has been much discussion among tea planters as to whether green material should be worked into the soil as green manure or made into a compost. On this subject, definite and good experiments have been made by H. R. Cooper, at the Assam Tea Research Station, and by T. Eden, of the Ceylon Research Institute. In no instance was there any evidence of the advantage of composting, and tea planters are now, therefore, recommended to dig in their green manures.

General Conclusion. The value of well-made composts in gardens, market gardens and nurseries is beyond doubt, though incontrovertible figures are not available to prove this. The accelerator may be inorganic, such as sulphate of ammonia plus chalk or limestone, cyanamide, Adco or other easily available nitrogenous compound: with the two former, phosphate is also needed; or the accelerator may be farmyard manure: easily decomposable vegetable matter: habitation wastes, household slops containing nitrogenous matter, etc. The value of composts on the farm is not yet established. The material most generally available is straw, but the difficulty of proper water supply is not yet overcome, and composts made with unsatisfactory water supply have not proved particularly effective. The better utilisation of waste straw on the farm is among the most important agricultural problems.

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PLOUGHING UP AND RE-SEEDING POOR GRASS LAND

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In the March, 1939, issue of this JOURNAL, an account was given of a series of trials in ploughing up and re-seeding poor grass land carried out in Yorkshire in 1938. These trials were continued in 1939, and, in addition, a further fourteen trials were started, giving a total of twenty-three, situated in various parts of the county.

1938 Trials. In the 1938 trials the following points were under investigation:—

- (1) The relative merits of ploughing up and re-seeding as compared with the renovation of the existing turf by harrowing, manuring, and re-seeding.
- (2) A comparison of spring seeding with summer seeding.
- (3) The use of a nurse crop as against no nurse crop.
- (4) The influence of fertilizers on the resulting sward.
- (5) The value of indigenous strains of grasses as compared with the cheaper commercial strains.

At the end of the first season certain conclusions were reached regarding these problems, and these have been confirmed by the behaviour of the plots in the second season. It might be appropriate at this stage to discuss the above points in turn.

(1) In the first season, renovated plots were very poor and compared badly with those ploughed and re-sown. It was evident that the existence of much original herbage was a limiting factor in getting a good establishment of the seeds mixture sown. At the end of the second year, the strong growing weed species, such as Bent and Yorkshire Fog, have gained the mastery over the perennial ryegrass and cocksfoot which were sown. The evidence obtained is *strongly in favour of using the plough* rather than the harrows for the improvement of poor grass land.

(2) Evidence from the first year showed that, where summer seeding is contemplated, ploughing should take place immediately prior to seeding, for where winter ploughing is followed by summer seeding, difficulty is experienced in keeping the land free from weeds in the period that the land is in the furrow. This point received further attention in 1939 trials, and, as will be shown later, the earlier result was confirmed.

(3) The conclusion reached after the first season that "a cereal nurse crop is not essential and the indications are that

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it is undesirable " has been confirmed in 1939. In the second year, those areas sown down under oats in 1938, are by no means so good as where re-seeding without a cereal nurse crop was carried out. On the former plots large quantities of Yorkshire Fog and Bent have become established and the sward is not so thick.

(4) That phosphates are essential has been confirmed in the second year of the trials. This has also been shown again in a striking manner in the new series of trials laid down in 1939. At the end of the first season, plots receiving lime and slag were no better than those receiving slag alone, and the plots with lime alone, whilst better than plots with no manure, were by no means so good as those receiving slag alone. This difference has continued to be marked in the second season, and farmers visiting the plots have been unable to distinguish between areas receiving lime and slag and those receiving slag alone, even on land where the lime requirement varied from 17 to 35 cwt. of calcium oxide per acre. At 3 centres (out of 9) towards the end of the 1939 growing season, there was some evidence (in the brighter green colour) to show that the lime and slag plots were gaining ground on the slag alone plots. Strangely enough, the plots receiving lime alone are by no means so good in the second year as in the first, and are now little better than the no-manure plots. The clover plants are diminishing in number and vigour, and weeds are rapidly spreading on these plots.

(5) So far, no striking differences have been noted between areas sown with indigenous species of grasses and those sown with commercial strains. Earlier grazing (7-10 days) has been obtained from the commercial species, and the yield of grass has been rather greater. It was noticed in the autumn of 1939 that, where plots had been inadequately grazed, the amount of " winter burn " of the commercial strains of cocksfoot was much greater than with the indigenous strains.

1939 Trials. At the end of the first season of the 1938 trials it was evident that further information was required on the following points:—

- (1) The minimum manuring that could be considered " safe," consistent with successful re-seeding.
- (2) The relative merits of winter ploughing and spring seeding, compared with summer ploughing and summer seeding.
- (3) The behaviour of a cheap and simple seeds mixture under re-seeding conditions.
- (4) The necessity for including Italian ryegrass as a nurse crop.

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Accordingly, 14 trials were laid down during 1939 with the object of getting an answer to these problems.

PLAN OF 1939 EXPERIMENTS. The centres were chosen in areas where much of the grass land was in urgent need of improvement. At all the centres the soil had a lime requirement varying from 17 to 44 cwt. of calcium oxide per acre. At 10 of the centres there was a deficiency of phosphate, and at 4 centres a deficiency of potash in addition to phosphate and lime.

Three acres of land were treated at each centre, and the layout of the plots was as indicated in the plan below.

Ploughed in Winter. Sown Down in Spring. No Nurse Crop.	Ploughed in Winter. Sown Down in Spring. Nurse Crop—Italian Ryegrass.	Ploughed in Summer. Sown Down in Summer. Nurse Crop—Italian Ryegrass.
Lime ..	$\frac{1}{2}$ ton per	acre
Slag ..	$\frac{1}{2}$ ton per	acre
Potash ..	2 cwt. per	acre
.....		
Slag ..	$\frac{1}{2}$ ton per	acre
.....		
Slag ..	1 ton per	acre
.....		
Lime ..	$\frac{1}{2}$ ton per	acre
Slag ..	$\frac{1}{2}$ ton per	acre
.....		
Lime ..	1 ton per	acre
Slag ..	$\frac{1}{2}$ ton per	acre

The whole area received 1 cwt. per acre nitro-chalk prior to sowing the seed. Best quality ground burnt lime was applied at most centres, and high soluble basic slag at all. The fertilizers were applied about one month before sowing the seeds, except for the summer-seeded plots, where manuring preceded seeding by a few days.

The same seeds mixture was used at all centres, viz :—

Perennial ryegrass (Ayrshire)	..	..	20	lb. per acre.
Cocksfoot (Danish)	..	..	10	" " "
Late flowering red clover	..	..	4	" " "
Wild white clover	..	..	1 $\frac{1}{2}$	" " "
				<hr/>
				35 $\frac{1}{2}$ lb. per acre.

Where Italian ryegrass was used as a nurse crop, 10 lb. per acre was added to the above mixture.

At five of the centres where rotational grazing was practised, a measure of the productivity of the different plots was

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obtained by weighing the grass from sample foot squares immediately before grazing commenced, care being taken to sample when the grass was dry. Ten such squares were taken from each plot and weighed on the spot. At those centres sampled in this way in 1938, the work was continued in 1939, and the average results for both sets of trials are shown in the tables below.

TABLE I.—WEIGHT (TONS PER ACRE) GRASS PRODUCED DURING SEASONS 1938 AND 1939
(Average figures for Four Centres)

Manuring	Complete Manuring		Lime and Slag		Slag		Lime		No Manures	
	1938	1939	1938	1939	1938	1939	1938	1939	1938	1939
SPRING SEEDING:										
Nurse crop, Italian ryegrass ..	13.07	12.78	10.86	12.85	10.56	12.65	8.77	8.98	6.00	6.86
No nurse crop ..	11.78	12.00	9.99	11.98	10.81	12.00	7.04	5.45	4.22	5.34
Nurse crop oats	—	9.52	—	9.66	—	9.27	—	6.01	—	5.92
SUMMER SEEDING:										
No nurse crop ..	4.56	12.50	2.77	12.25	2.60	13.00	1.98	9.05	0.84	6.00
CONTROL (Original sward) ..									3.97	4.60

TABLE II.—WEIGHT (TONS PER ACRE) GRASS PRODUCED DURING SEASON, 1939
(Average figures for 5 Centres laid down in 1939.)

Manuring* (per Acre)	Spring Seeding, No Nurse Crop	Spring Seeding Nurse Crop, Italian Ryegrass	Summer Seeding Nurse Crop, Italian Ryegrass
Lime, $\frac{1}{2}$ ton ; slag, $\frac{1}{2}$ ton ; Muriate of potash, 2 cwt. ..	14.25	15.56	5.22
Slag, $\frac{1}{2}$ ton ..	14.58	15.63	5.00
Slag, 1 ton ..	14.23	15.48	5.15
Lime, $\frac{1}{2}$ ton ; slag, $\frac{1}{2}$ ton ..	14.46	15.22	5.05
Lime, 1 ton ; slag, $\frac{1}{2}$ ton ..	14.56	15.48	5.35

Original sward (no manuring) gave 4.25 tons per acre. * The whole area received 1 cwt. per acre nitrochalk in addition to manures specified in table.

Discussion of Results. The need for really good ploughing must again be emphasized. The best results were obtained by the use of a furrow press following a plough which turned a flat furrow. Tandem disc harrows were found best for breaking down the furrows and, prior to seeding, the Cambridge roller was used to give consolidation to the seed-bed. After seeding, the lightest of harrows were sufficient to

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cover the seed. Wherever indifferent ploughing was done, some of the original weed species of grass have established themselves, and will doubtless spread as time goes on.

The inclusion of Italian ryegrass as a nurse crop gave 7-10 days earlier grazing in the first instance, and the pasture was ready for grazing again 3-4 days before areas sown without Italian ryegrass. In addition, the growth was thicker throughout the season, and the results so far obtained would suggest that the inclusion of Italian ryegrass in the seeds mixture is well worth while.

Regarding summer ploughing and seeding, uniformly good results have been obtained, and the swards are now well established. It must be remembered, however, that last summer was exceptionally wet and very favourable for summer seeding, and further experience in a dry season is necessary before general conclusions are drawn on this point. It must be stressed, however, that greater care is necessary to get good consolidation of the furrows with summer ploughing than when ploughing takes place in winter, and time is allowed for natural settling to take place.

At all centres it is impossible to discern by eye any variation between the different manurial treatments, nor do the figures for yield show marked differences. This again demonstrates the need for adequate phosphating, and, as in the 1938 trials, an application of 10 cwt. per acre of high-grade, high-soluble basic slag has given excellent results.

Taking into account the experience of both series of trials, it would appear that where initial cash outlay must be kept at a minimum, an application of $\frac{1}{2}$ ton per acre basic slag, plus 1 cwt. per acre nitro-chalk, is sufficient to give good establishment and to maintain the sward for the first two years. What will happen to these plots in subsequent years will be of considerable interest, for the addition of lime and potash may then show to advantage.

The simple seeds mixture used in these trials has proved satisfactory, and has stood up to the heavy stocking well. More time must elapse, however, before one is in a position to determine if the sward can be maintained in this condition.

In several instances an amazing growth of weeds followed the re-seeding, the chief offenders being red shank, fat hen, and creeping thistle. The red shank and fat hen have disappeared in the course of the grazing season, but the thistles are more persistent. Frequent scything has kept them in check.

PLOUGHING UP AND RE-SEEDING POOR GRASS LAND

On most plots, grazing commenced as soon as possible, which, as a rule, was about eight weeks after seeding. Grazing was heavy and care was taken to get the plots well grazed down, before resting the fields prior to stocking again. Young stock were mostly used for this, although in one instance three-year-old bullocks were finished on the new sward and in two cases milk cows were used. Where the crop was allowed to grow up for hay, the sward is open in the bottom and shows a general coarseness compared with the comparatively fine and closely knit sward at centres where grazing was carried out. At all centres the grazing season has been considerably extended by re-seeding.

Conclusions. It is not desirable to draw conclusions until further time has elapsed and the behaviour of the plots has been noted under varying weather conditions. The following points, however, are worthy of emphasis.

(1) Ploughing must be well done. A flat furrow is to be preferred, the old turf must be buried, and the seedbed firm. The furrows are best broken down with disc harrows, and the Cambridge roller should be used before sowing the seed.

(2) Phosphates are essential. In both 1938 and 1939, an application of high-grade, high-soluble basic slag at the rate of $\frac{1}{2}$ ton per acre has given excellent results.

(3) An application of nitrogenous fertilizer at seeding time is helpful in getting rapid establishment of the sward.

(4) The inclusion of Italian ryegrass as a nurse crop (10 lb. per acre was used) adds to the bulk of herbage produced and gives earlier grazing. It further helps to cover the ground and so keep the weeds in check.

(5) The fields should be grazed rather than mown in the first year. Grazing should commence as soon as the grasses are 4-6 in. high, and should continue at intervals throughout the season.

(6) Summer ploughing and re-seeding gave good results, but further evidence is necessary in a dry season before conclusions can be drawn.

(7) The simple seeds mixture used in the trials has proved very satisfactory in the first year.

PLOUGHING UP AND RE-SFEDING



FIG. 1. - Yorkshire Dales. Worthless grass ploughed and re-sown Spring 1938. Photograph taken May 17, 1939

May 17-June 10	..	28 Heifers	September 16	..	62 Lambs
July 16-August 5	..	128 Heifers	October 4-November 1	..	5 Heifers
		.. 112 Sheep			

This field 14 Acres carried in 1930 —

Gas pumped and resurfaced 1935 — Photograph taken May 17, 1935

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PLOUGHING UP AND RE-SEEDING

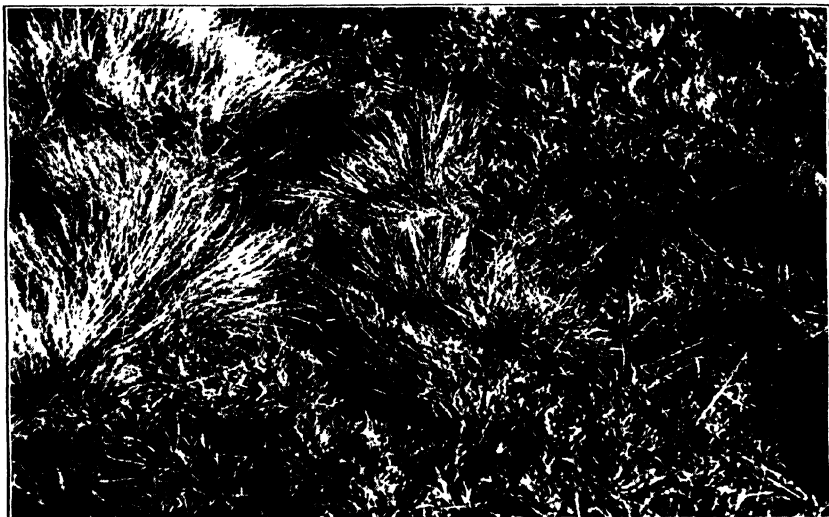


FIG. 2 — Poor moorland pasture
Before ploughing — Moor mat grass, Fine leaved fescue, and bent



FIG. 3 — Same field as above 9 weeks after re-seeding in spring, 1938.
Received complete manuring
Perennial rye-grass, cocksfoot, and late flowering red clover

PLOUGHING UP AND RE-SEEDING



FIG. 4 Ploughed and re-sown spring, 1938. Appearance of sward May, 1939.
Foreground—No manure (note large amount of bare ground).
Background—Complete manure.



FIG. 5 Poor moorland pasture 850 feet above sea level.
 Appearance of sward on July 16, 1939, after grazing—untreated area
 refused by stock.
Left—Ploughed and re-sown May 12, 1939.
Right—Untreated (lime requirement 42 cwt. p a. CaO).

CONTROL OF CABBAGE ROOT FLY



FIG. 2.—Brassica plant treated with 4 per cent calomel dust

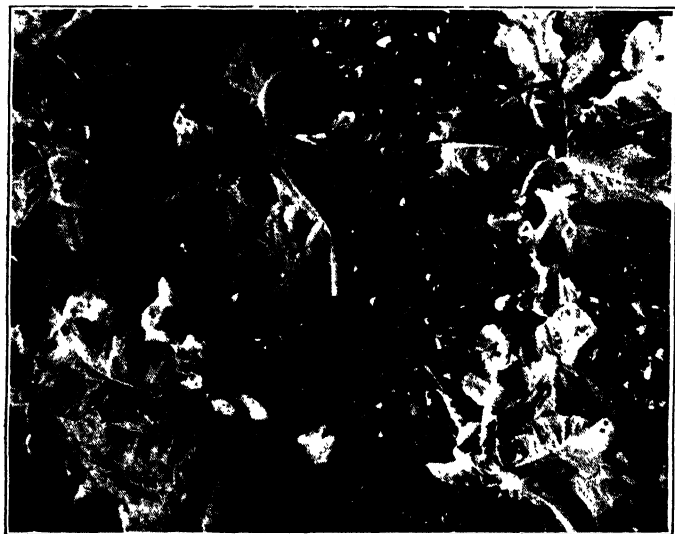


FIG. 1.—Plants in foreground wilting in the rows in following root maggot attack.

THE CONTROL OF CABBAGE ROOT FLY

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The Cabbage Root Fly (*Delia* [*Hylemyia*] *brassicae*, *Bouché*) is one of the most troublesome and consistently destructive insect pests with which the brassica grower has to contend. Attack may occur at any stage of growth, but plants recently set out usually suffer most. Damage is caused by the larval or maggot stage of the fly, which feeds below ground on the root system of the plant. Heavily attacked plants fail to grow normally, become sickly blue in colour and are killed or at best make only poor growth (see Fig. 1). Such plants are easily pulled out of the ground, their main and side roots having been badly mutilated, or even completely destroyed, by the maggots. Very severe infestations, killing off the majority of the plants in a crop, occasionally occur. More frequently, however, a few plants only are killed and the remainder reach maturity. The grower then usually assesses the damage caused by the pest in direct proportion to the number of plants lost. Almost invariably, this greatly underestimates the damage. Observations have shown that a far greater number of plants than those actually killed also suffer from root maggot injury. The presence of even a few maggots feeding at the roots, although insufficient to cause death, does have a pronounced checking effect upon the plant. The limited time available for growth makes this handicap one which is rarely overcome, and the resulting crop is adversely affected both in size and in quality. The experiments described below illustrate these points.

In certain circumstances, slight or moderate injury of the root system appears to be followed by further complications. Several severe cases of root rot in broccoli and brussels sprouts, occurring in early winter, have been investigated. In one case more than 90 per cent. of a broccoli crop was lost. The damaged condition of the root system and the presence of cabbage root fly pupae in the soil nearby led to the conclusion that a late summer attack of this pest had caused wounds through which various pathogenic soil organisms had entered. These had caused extensive rotting of the root system and death of the plant.

Life History. To formulate successful control measures, a detailed knowledge of the biology of a pest is usually essential. During 1939, observations were made on the times

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of emergence of the first adults of each generation, their periods of abundance and the relative frequency of eggs throughout the season.

The winter is passed in the pupal stage in the soil. With the rise of temperature in spring, hibernation ends and the adult flies commence to emerge. Flies of the first generation were first taken in the field on April 17, and became abundant during the last three weeks of May and the first week of June. Second-generation flies began to emerge on June 20, and reached maximum numbers in the last week of June and the first three weeks of July. Emergence of the third generation began on July 25, and continued slowly throughout August until the second week of September without showing any definite peak period.

The first eggs of the season were found on May 4; periods of abundance were the latter half of May and early June, and throughout July and early August. The cold weather of late April probably prevented the earlier appearance of the first eggs; in 1938, they were first found on April 27. From May until the second week of September, recently-laid eggs could be found in the field at all times. This apparently continuous supply of eggs, brought about by considerable overlapping of generations, indicates that "fly-free" periods during summer do not exist and that susceptible crops growing during this period should be treated to prevent attack.

Control of Cabbage Root Maggot. Experiments in 1938 showed that the root systems of early cauliflowers could be protected from maggot attack by an application of 4 per cent. calomel dust to the soil round the base of the plant. Two applications of the dust gave far better results than either a single application of dust or three dressings of corrosive sublimate.* Further experiments on similar lines were carried out in 1939.

EXPERIMENTS WITH EARLY CAULIFLOWERS, 1939. (1) *Entomological Field Station, Cambridge.* The treatments shown in Table I were included.

Calomel dust was applied with a hand duster of the piston type, one or two puffs from which were sufficient to form a cover of dust on the soil round the base of the plant (see Fig. 1). The corrosive sublimate solution was watered round the plant as normally prescribed.

* For a description of this pest and an account of previous experiments, reference should be made to this JOURNAL, November, 1938.

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TABLE I

Treatment	Rate of Application	Number of applications	Times of application
I. Calomel dust, 4 per cent.	45 lb. per 4,840 plants	1	April 21
II. Calomel dust, 4 per cent.	30 lb. per 4,840 plants	2	April 21 May 5
III. Corrosive sublimate, 1 oz. per 10 gal. water.	1 pint per plant	2	April 21 May 5
IV. Control (untreated) ..	---	---	---

The plants were set out from pots on April 19. There were four plots of each treatment and the experiment took the form of a Latin square. Each plot contained 56 plants set 2 ft. by 2 ft.

Root fly eggs were first observed on the plots on May 5; by the end of the month the egg infection appeared to be 100 per cent. on all plots. A heavy attack did not materialize and no plants were killed. By mid-June, however, there was a marked difference between the calomel-treated and the remaining plots. Plants on the former were larger, with leaves of a darker green colour and, in general, lacked the blue and purplish tints so common in those on the corrosive sublimate and control plots. Cutting commenced on July 13 and ended August 8. At each cutting, the heads from each plot were weighed and graded into 1st, 2nd, 3rd classes, which corresponded to curd diameters of 5 in. and over, 3-5 in., and under 3 in. respectively. The results are shown in Table II:—

TABLE II.—YIELDS FROM EARLY CAULIFLOWER EXPERIMENT,
E.F.S., 1939

Treatments	I	II	III	IV
	lb. oz.	lb. oz.	lb. oz.	lb. oz.
Total weight of heads cut from 4 plots	128 4	127 6	81 5	78 14
Increase in weight of heads compared with controls (per cent.)	62.6	61.6	3.1	—
Number of 1st grade heads (per cent.)	55.9	50.5	23.5	20.5
Number of 2nd grade heads (per cent.)	41.1	48.1	68.4	65.5
Number of 3rd grade heads (per cent.)	3.0	1.4	8.1	14.0
Increase in number of 1st grade heads compared with controls (per cent.)*	176	156	12	---

* Calculated from actual numbers of 1st grade heads,

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It will be seen that one application of 4 per cent. calomel dust of 45 lb. per 4,840 plants (Treatment I) increased the weight of heads cut by 62.6 per cent., and nearly trebled the number of 1st grade heads as compared with the yield from the untreated plots (Treatment IV). Two applications of dust, each at 30 lb. per 4,840 plants (Treatment II) gave results very similar to those obtained from a single heavier application. No significant crop improvement resulted from two applications of corrosive sublimate (Treatment III).

The extent by which these cropping differences were linked up with differences of maggot infestation was determined by examination of the root systems on the different treatments. From each plot, 40 stumps were examined and each stump graded according to severity of damage into one of the following groups: unattacked, slightly attacked, moderately attacked and heavily attacked. The degree of infestation for the different treatments is given in Table III.

TABLE III

Treatment		Degree of Maggot Attack (per cent.)			
		Unattacked	Slight	Moderate	Heavy
I	..	60.0	27.5	11.9	0.6
II	..	69.4	26.2	4.4	0
III	..	0	19.5	33.1	47.4
IV	..	0	14.4	30.6	55.0

The results indicate that yield is directly correlated with degree of root maggot infestation; the greater the damage to the root system, the lower the resulting crop yield.

(2) *Horticultural Research Station, Cambridge.* Treatments I, II and IV were the same as those carried out in the previous experiment. In Treatment III two applications of 4 per cent. calomel dust, each at 30 lb. per 4,840 plants, were applied (as in Treatment II), but the first dressing was not put on until 14 days after the first root fly eggs were found on these plots. A second dressing was applied 14 days later, the actual dates of application being May 23 and June 6.

Root maggot attack in this experiment was more severe than in the previous one, a number of plants in both Treatments III and IV being killed. In Treatments I and II, however, no plants were lost and the plots of these treatments could be easily picked out by the colour of the plants and their much greater vigour and uniformity. The crop was

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cut, weighed and graded as previously described, and the following results were obtained:—

TABLE IV.—YIELDS FROM EARLY CAULIFLOWER EXPERIMENT.
H.R.S., 1939

Treatments	I		II		III		IV	
	1 applica- tion dust at 45 lb. per 4,840 plants		2 applica- tions dust each at 30 lb. per 4,840 plants		Do. Treat- ment II, but appli- cation delayed		Control (untreated)	
	lb.	oz.	lb.	oz.	lb.	oz.	lb.	oz.
Total weight of heads cut ..	206	10	184	2	142	12	112	9
Increase in weight of heads compared with controls (per cent.)	83.5		63.5		26.7		—	
Number of 1st grade heads (per cent.)	71.1		61.5		43.7		30.6	
Number of 2nd grade heads (per cent.)	25.6		35.1		42.6		57.1	
Number of 3rd grade heads (per cent.)	3.3		3.4		13.7		12.3	
Increase in number of 1st grade heads compared with control (per cent.)*	184.4		137.8		55.6		—	

* Calculated from actual number of 1st grade heads.

The yield and quality of the crop from plots of Treatments I and II were again very similar. The importance of correctly timing the applications of dust is demonstrated by comparing the yields obtained from plots of Treatments II and III. It will be seen that, both in total weight and in quality, the crop from Treatment III plots compares poorly with that from Treatment II. Both series of plots received two applications of calomel dust, the only difference being that plots of Treatment III were dressed 14 days later than those of Treatment II, during which time egg laying and infection by root maggots occurred.

An examination of the root systems on the various treatment plots gave the following figures for maggot infestation

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(Table V). Grading according to severity of damage was carried out as before.

TABLE V

Treatment		Degree of Maggot Attack (per cent.)			
		Unattacked	Slight	Moderate	Heavy
I	..	49	48	3	0
II	..	53	47	0	0
III	..	5	17	23	55
IV	..	0	5	29	66

A comparison of the root attack on Treatments II and III clearly shows the vital importance of carrying out control measures before an expected attack commences. As in the previous experiment, high yield is again correlated with low maggot injury and vice versa.

Control of Root Fly in Spring-sown Brussels Sprouts.

Five replicates of five different treatments were tested at the Entomological Field Station, Cambridge. The maggot attack was slight and no plants were lost or showed signs of distress. Although complete results are not yet available, the first three pickings of sprouts and the tops have shown significant yield differences on the different treatments. Two applications of calomel dust, each at 30 lb. per 4,840 plants, put on 2 and 16 days after setting out, resulted in a 30 per cent. increase in yield as compared with the yield from the untreated plots. A single heavier application at 45 lb. per 4,840 plants gave only a 19 per cent. increase. Three applications of corrosive sublimate (1 oz. per 10 gal. water) resulted in no improvement in yield.

In contrast with the results obtained with cauliflowers, two applications of calomel dust to the Brussels sprouts gave a better result than a single heavier application. This is probably because the Brussels sprouts have a longer growing period during which protection is necessary.

In comparison with the attack frequently observed on commercial crops, the damage caused by the cabbage root fly in these three experiments would be described as slight. Yet the increase in total yield resulting from the prevention of this attack ranged from 30 to 83 per cent., and was accompanied by an improvement in quality of up to 184 per cent. For most brassica crops, a 15 per cent. increase in yield accompanied by improvement in quality, should cover the cost of

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calomel treatment. Observations carried out in several brassica-growing districts indicate that cabbage root maggot damage is extremely prevalent. Under these conditions, the cost of the treatment, if properly carried out, should be repaid many times over.

Mode of Action of Calomel. Experiments carried out in the laboratory have shown that calomel is very toxic to certain insect eggs. Cabbage root fly eggs, placed either in contact with calomel or subjected to its vapour, fail to hatch. Calomel dusts, being calomel diluted with a finely divided and usually inert filler, act similarly. Observations and tests carried out in the field have shown that control there by calomel is brought about by the same mode of action. In one field experiment, plants were treated with one application of 4 per cent. calomel dust at the rate of 45 lb. per 4,840 plants. Five weeks later 50 eggs were collected around these plants and examined. All were found to be unhatched and many were dark in colour and collapsing. Washing and incubation for 7 days failed to bring about hatching. A similar sample of eggs from neighbouring untreated plants was 50 per cent. hatched at the time of collection, and incubation produced a 94 per cent. total hatch. Four weeks later, a second sample of eggs was taken from the treated plants. Examination showed that some 4 per cent. had hatched in the field, and another larva emerged during incubation. The total egg mortality in this instance was 94 per cent. Eggs collected at the same time from the untreated plants gave a 96 per cent. hatch.

The protection afforded by two applications of 4 per cent. calomel dust, each at 30 lb. per 4,840 plants, was also tested in the field. Of the eggs collected nine weeks after the dust had been applied, only 3 per cent. had hatched. Incubation of the remainder failed to induce further hatching. Small quantities of calomel dust were still visible on the soil when these collections were made.

Cultivations. Since egg laying by the cabbage root fly appears to proceed continuously throughout the summer, any treatment which is to be successful must present a barrier to this attack. It is, therefore, of vital importance that the calomel dust should remain undisturbed round the base of the plant for as long as possible. Close hoeing or weeding of treated plants should be strictly avoided.

Method of Application. The dust should be applied to the

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soil round the base of the plant as shown in Fig. 2. As much as possible should be deposited within one inch of the base of the stem, where the eggs are laid.

On the field scale, a duster, capable of giving definite "puffs" of dust and not a continuous stream, should be used. The duster should be capable of holding several pounds of dust and be equipped with a long delivery lance to enable the worker to remain upright while using it. Although the ideal type of duster, one capable of delivering a constant quantity of dust at each stroke and capable of regulation, has not been discovered, several types are available which, by careful manipulation, can be made to deliver the dust satisfactorily. During application, the tip of the lance should be placed close to the base of the plant and the duster should be so regulated that in one or, at most, two strokes the desired quantity is applied. A fish tail or other means of spreading the dust should not be used.

In gardens and allotments, the dust can be most satisfactorily applied with a teaspoon. About half a teaspoonful—sufficient to form a complete collar around the base of each plant—should be used at each application.

Recommendations. (1) *Brassica plants* set out before the *last week of April* should receive an application of calomel dust in the *last week of April*. Plants set out *during or after the last week of April* should receive an application of dust *within 4 days of setting out*.

(2) *Cauliflowers* should receive a single application of calomel dust at the rate of 45 lb. per 4,840 plants.

(3) *Brussels sprouts and broccoli* should receive two applications of calomel dust each at 30 lb. per 4,840 plants. The second application should be put on two to three weeks after the first.

It is emphasized that these quantities were the minimum required to give a satisfactory control under the conditions in which the trials were carried out. Experiments have also shown that, within certain limits, the degree of protection from root maggot increases as the rate of application of calomel dust is increased. With certain valuable crops, therefore, an increase of up to 50 per cent. in the rate of dust applied may be a sound economic proposition.

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SHEEP FEEDING*

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Our flocks of sheep have an especially important part to play under present conditions. The great advantage of sheep in time of war is that they produce meat without making any large inroads on our limited supplies of corn and cake, thus saving the demand on our shipping. Even in normal times, our flocks probably get about six-sevenths of their foods from pastures, roots, hay, etc., and only one-seventh from concentrates. Compared with this, cattle get a fifth of their food as concentrates, and pigs more than nine-tenths. The flocks that make the heaviest demands on the corn-bin are those producing early fat lamb; but it will be in the nation's interest to feed this season's lambs less heavily than usual, to keep them longer and to market at bigger weights.

Provided we can produce reasonable quantities of roots, kale and good-quality hay or silage for the winter, all classes of sheep can make use of the bulkier and cheaper concentrates, such as undecorticated cotton cake, locust beans, dried brewery and distillery grains and sugar-beet pulp. This will save the available supplies of corn and the richer sorts of cake for other classes of stock.

It is also frequently possible, by care and forethought, to make fuller use in sheep-feeding of various by-products and oddments—sugar-beet tops, the pickings of stubbles, pea haulm, the leaves of cabbage and Brussels sprouts, bean chaff and the poorest tail-corn. Another important matter to keep in mind is that of fitting some catch-crops into our schemes of cropping for the coming season.

There are, of course, many farms where the flock is already as large as can safely be carried, and where any increase in numbers would be likely to make the land sheep-sick. But there are also numbers of farms which are carrying no sheep, and where the keep of a score or two of ewes would hardly

*This article has been reprinted as "Growmore" Leaflet No. 19, copies of which may be obtained free on application to the Ministry.

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be missed. In some, the absence of sheep-proof fences is a difficulty, but this can often be overcome at no great cost. Sheep generally give little trouble, and thrive well, on land that has not lately carried a flock.

Ewe Flocks on Grass Land. The early spring is usually the most difficult time for the grassland breeding flock. Until spring grass comes, a full flow of milk from the ewe, which is so necessary for the making of a good lamb, can be got only at the cost of heavy feeding. An early bite, on one or two grass fields, is, therefore, worth a great deal.

Most of our pastures made strong autumn growth last season, and the plants should therefore be in good condition to respond to forcing treatment this spring. An early bite will best be obtained from a field that has not been grazed in the late autumn or winter. Choose if possible one in a sheltered position, then in February or March give a dressing of about 1 cwt. per acre of nitrochalk, nitrate of soda or sulphate of ammonia. The outcome will, of course, depend on the weather, for early growth needs a certain degree of warmth as well as a supply of quick-acting nitrogen. But in two years out of three a field that has been treated on these lines will produce useful keep a fortnight or three weeks earlier than the general run of pastures. A good sward, containing plenty of ryegrass and cocksfoot, gives the best response. The Ministry has published a "Growmore" Leaflet (No. 15) on Early Bite, and copies may be obtained free on application to the Ministry.

After the hungry early spring there usually follows, in May or early June, a flush of grass, and it often happens that the stock cannot keep pace with the growth. To have sheep up to their knees in grass is bad from every point of view. It means that good food is being wasted. Besides, lambs make poor progress on overgrown pasture, for it is the young blade of the grass that makes both for growth and fattening. The best plan for dealing with the surplus is to shut up fields as soon as they can be spared and to mow them early, two or three weeks before the crop would have reached the hay stage. With settled weather, the crop may be made into hay, but it should be cocked up as soon as possible and left in cock till it is thoroughly cured.

Young leafy material is difficult to collect if it is dried out on the ground, and if carried too soon is very liable to over-

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heat in the rick. If the weather is unpromising, the making of molassed silage (using three or four gallons of molasses, diluted in an equal volume of water, to the ton of grass) will be preferable to hay making. The ensilage of immature herbage is best undertaken in a specially built container, such as one of the modern portable silos. The crop, whether as hay or silage, will be a valuable addition to the winter store for the flock. A field so treated will provide fresh clean keep for the flock some weeks before the ordinary aftermaths are available.

If, as seems likely, normal supplies of lamb food will not be available during the war, careful management and frequent changes of pasture will be more necessary than usual. In many parts of the country, stomach worm is the commonest cause of the failure of lambs to thrive on grass, and it is generally recognized that the feeding of concentrates helps to overcome the effects of infestation. It will, therefore, be well to be prepared to undertake medicinal treatment at the first sign of trouble.

The symptoms of stomach-worm infestation may be irregular scouring, a dry and harsh fleece, and loss of condition, although at times lambs may actually die before diarrhoea is seen and before there has been time for them to lose condition. Further information on this subject will be found in Advisory Leaflet No. 275.

Catch Crops for Weaned Lambs. In late summer and autumn, catch crops are a great asset, partly because of their food value and partly because they provide a change from stale pastures to clean ground. In many years, a useful autumn bite can be grown at little cost by undersowing a field or two of corn with a few pounds each of red clover, trefoil and Italian ryegrass. The growth of young seeds, with the oddments of corn, make a ration on which lambs thrive remarkably, and the clover root and the droppings make a useful manure for the following crop.

Where the corn crop is winter oats it may be possible in early districts to sow the catch crop immediately after harvest—to plough with a shallow furrow, work down a tilth and to broadcast early maturing turnips or (if the land is not wanted till spring) a mixture of hardy green turnips with rape or Italian ryegrass.

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Growing Winter Keep. Among all the crops that we grow, roots and kale produce the largest amounts of food value per acre. With swedes and kale for the winter, a clamp of mangolds or silage for the spring and a stack of clover or seeds hay, the flock becomes practically independent of the corn merchant.

Labour difficulties may prevent any increase in the usual acreage of swedes or mangolds—it is useless to sow more roots than can be singled and kept hoed. Kale can be grown at much less labour cost, especially if the land is fairly free from annual weeds, as newly ploughed-out grass land usually is. If kale is drilled rather thinly, there is no need to single for purposes of sheep keep—indeed, in some experiments unsingled crops have given the higher yields. Moreover, if the crop is horse-hoed early, and is given a nitrogenous top dressing, it will generally smother out any weed growth.

Kale grows well on ploughed-up turf, and a kale crop might well be of more value than spring oats, especially if the latter crop is late sown. Kale is, of course, very useful keep for all classes of stock, but it is the general opinion that swedes are better for the later stages of fattening.

Winter Fattening Togs. A great many old experiments, carried out in days when imported feeding stuffs were comparatively dear, show that good results can be got with only small amounts of concentrates. Indeed, at one time many togs were fattened out on roots and hay alone. In one experiment, a lot of 80 lb. stores were fed on 15 lb. of swedes and $\frac{3}{4}$ lb. hay per day, with no other food, and made very nearly $1\frac{1}{2}$ lb. live-weight increase per week. Another lot, having $\frac{3}{4}$ lb. undecorticated cotton cake, 14 lb. of swedes and half a pound of hay per day, made a weekly gain of $2\frac{1}{2}$ lb. In another trial 90 lb. stores which had a daily ration of 16 lb. swedes, $\frac{1}{2}$ lb. of hay and $\frac{1}{2}$ lb. each of undecorticated cotton cake and dried grains, made a liveweight gain of $2\frac{1}{2}$ lb. per week and got fat in three and a half months.

The less fibrous concentrates, like linseed cakes and flaked maize, will naturally give quicker fattening, but if only small amounts are available they will be best used in the last few weeks before the sheep go to the butcher. On many farms this class of concentrates could be more profitably used for other kinds of stock.

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The Breeding Ewe in Winter. Grassland ewes can find a living on winter pasture for a longer or shorter time, depending on the quality of the herbage, the density of the stocking and the weather. Under the best conditions they may get through to lambing time with nothing but a little hay in hard weather. Stored turnips or swedes are a useful supplement, but roots are essentially a fattening food and their excessive use makes for weakly lambs and a poor flow of milk.

In the absence of concentrates, short-grass silage is a better food. Where only a little concentrate is available, it should be reserved until the flock is within three or four weeks of lambing. A lean ewe that is in improving condition will milk better than a fat one that is losing condition. Another point is that the ewe requires, just as much as the cow, a balanced milk ration. Beet pulp, for instance, must be balanced with a fair proportion of cake.

The Use of Sugar-beet By-products. The expansion of the beet acreage will provide larger supplies of beet-tops and beet pulp, which should be used to full advantage. There is often a heavy waste when tops are consumed on the beet field, especially when the sheep are kept day and night on the land, and when the weather is wet. If labour is available for carting, the tops will keep the flock longer if they can be spread thinly on pasture. Otherwise it will help to avoid waste if the sheep can be run on the beet field for three or four hours a day, being turned back on to pasture when they have had a good meal. If more beet tops are available than are likely to be used before Christmas, the surplus should be made into silage.

Dried beet pulp, as many experiments have shown, is an excellent substitute for roots, a pound of pulp being equal in food value to seven pounds of swedes. It is always best to hold over the pulp till the late winter and spring, for it is not subject to wastage, as most winter forage crops are. Satisfactory fattening can be got by replacing the whole of the root ration by pulp—say 2 lb. of pulp in place of a stone of swedes. Sheep fed on dry rations must, of course, be well supplied with water.

Fattening Yearling Sheep Indoors and on Grass. Where out-door conditions are unfavourable, limited number of hoggets can often be fattened more quickly in an airy shed.

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They may be fed on similar lines to sheep in folds. Instead, however, of carting and cutting roots for them it will generally be more convenient to feed beet-pulp and give access to water. This also makes for greater cleanliness in the shed. Rock salt should be provided.

A shortage of concentrates may make it impossible to fatten tegs as early in winter as usual, and numbers may have to be held over and finished on summer grass. Such sheep should then be run as thinly as possible and should have a small daily allowance of rather binding food—say one part of cotton cake to two of beet pulp or maize. They should be turned to grass before there is much new growth, otherwise the sudden change will result in a set-back.

MISCELLANEA

Trial of Haricot Beans in 1939

Haricot beans, the dried seeds of certain varieties of what is known in England as the French bean, *Phaseolus vulgaris*, being rich in protein, constitute a valuable source of nutritious food. Types of these beans form the raw material of such canned products as "baked beans," "pork and beans," etc. In order to discover whether crops of haricot beans could be grown successfully in this country, certain representative varieties were submitted for trial at several widely separated centres chosen to provide a full range of varying soil and climatic conditions. The varieties selected were: Brown Dutch, Inépuisable, White Leviathan, Masterpiece, Comtesse de Chambord, and Prédome à rames, the last a climbing type, not planted at all the centres.

The following useful record of the characters of each variety has been provided by the staff at the Royal Horticultural Society's Gardens, Wisley:—

Brown Dutch. Plant 15 in. tall; pods 4-4½ in. long by ½ in. wide, well above the soil; seeds in pods up to 5, round in section, brown, often truncate at ends; ripens well and shells easily. Ready as haricots end of September.

Inépuisable. Also known as "Everbearing." Plant 16 in. tall, bearing flowers in very large clusters, well above the foliage, many of which fail to set; pods 5-6 in. long by ¾-1 in. wide; seeds in pods up to 5, flattish oval, truncate, white; ripens well and shells easily. Ready as haricots mid-September.

White Leviathan. Also known as "White Haricot." Plant 18 in. tall; pods 5-6½ in. long by ½ in. wide, well above the soil; seeds in pods up to 6, flat oval, kidney shaped, white, some with a greenish tint; ripens well and shells easily. Ready as haricots mid-September.

Masterpiece. Plant 16 in. tall; pods 6-7 in. long by ½ in. wide, above the soil; seeds in pods up to 5, roundish in section, almost straight or kidney, pale dun; ripens well and shells easily. Ready as haricots early September.

Comtesse de Chambord. Also known as "Dwarf White Rice." Plant of low spreading habit, almost semi-climbing but not requiring support; pods just above the soil, 3-3½ in. long, flattish oval, ¾ in. wide; seeds in pods 3 or 5 in a pod, round oval, very small, more or less truncate, white; ripens well and fairly easy to shell. Ready as haricots end of September.

The trials were conducted at the following institutions:—

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|--------|------|--|
| Centre | I. | Midland Agricultural College, Sutton Bonington, Leicester. |
| " | II. | Horticultural Research Station Cambridge. |
| " | III. | Royal Horticultural Society's Gardens, Wisley, Surrey. |
| " | IV. | Cannington Court Farm Institute, Somerset. |
| " | V. | South-Eastern Agricultural College, Wye, Kent. |
| " | VI. | John Innes Horticultural Institution, Merton, Surrey. |

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Lord Wandsworth Agricultural College, Basingstoke, Hampshire.

Sparsholt Farm Institute, Hampshire.

Kirton Agricultural Institute, Lincolnshire.

Hutton Institute of Agriculture, Lancashire.

School of Agriculture, Houghall, Durham.

It was arranged that the trials should be carried out under conditions approximating to commercial practice as nearly as possible, and accordingly at several of the centres the seeds were planted under farming conditions.

Cultivation. The seeds were sown in May in rows 2 ft. apart with a space of 1 ft. between the plants. The dry conditions, amounting to drought at some of the centres, which followed sowing and held for several weeks, interfered with germination and also affected subsequent growth. It was noted that under drought conditions some varieties, notably *Inépuisable*, germinated less well than others. Predatory birds and animals were an added source of trouble at some centres, notably Sparsholt, where the damage was severe enough to render the trial useless. A further complication arose out of the fact that all the varieties selected for trial were affected more or less with Mosaic, a virus disease that is a common trouble with French beans.

Results. As was anticipated, the results under such varied conditions were not uniform. The trials were most successful at Centres Nos. I, II, III, IV, V, and VI, and although a uniform system of reporting on the trials was not originally worked out, it has been possible to compile the following statement from the data supplied by these centres:—

Centre		Brown Dutch	Inépuisable	White Leviathan	Masterpiece	Comtesse de Chambord
I.	No. of Plants ..	300	300	300	300	300
	Wt. harvested ..	9 lb. 4 oz.	4 lb. 4 oz.	6 lb. 8 oz.	7 lb. 5 oz.	6 lb. 10 oz.
II.	No. of plants ..	288	296	299	291	298
	Wt. harvested ..	29 lb. 10 oz.	28 lb. 14 oz.	33 lb. 6 oz.	25 lb. 0 oz.	38 lb. 8 oz.
III.	No. of plants ..	353	369	371	449	386
	Wt. harvested ..	42 lb. 0 oz.	28 lb. 4 oz.	37 lb. 8 oz.	39 lb. 12 oz.	51 lb. 8 oz.
IV.	No. of plants ..	60	60	60	60	60
	Wt. harvested ..	1 lb. 5 oz.	2 lb. 0 oz.	3 lb. 4 oz.	2 lb. 6 oz.	3 lb. 5 oz.
V.	No. of plants ..	200	200	200	200	200
	Wt. harvested ..	9 lb. 7 oz.	6 lb. 12 oz.	12 lb. 5 oz.	9 lb. 5 oz.	13 lb. 10 oz.
VI.	No. of plants ..	20	20	20	20	20
	Wt. harvested ..	1 lb. 2½ oz.	1 lb. 5 oz.	2 lb. 2 oz.	1 lb. 6½ oz.	2 lb. 13 oz.
III.	Estimated Yield per Acre. —	18½ cwt.	16 cwt.	16 cwt.	17 cwt.	22 cwt.
VI.	—	11½ „	—	—	—	27½ „

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It should be borne in mind that the weather of 1939, a cold and dry summer followed by a wet autumn, was distinctly unfavourable for this type of crop. The crops matured during September, but natural harvesting was impossible, and the crop at most centres had to be dried artificially.

The important factor in the production of dried haricot beans is the period of time which elapses between date of sowing and the maturing of the crop.

As regards yield, the four haricot varieties, Brown Dutch, Inépuisable, Comtesse de Chambord and Leviathan, despite the handicap of weather and disease conditions, all yielded satisfactorily at the centres mentioned. The average yields of this type of bean in various parts of the world when grown under farming conditions is not high and seldom exceeds 20 cwt. per acre even with the use of the most suitable varieties.

Sufficient evidence was obtained to support the view that the variety Comtesse de Chambord is from several points of view, notably growth and cropping capacity, ability to withstand adverse climatic conditions, appearance of harvested sample and edible quality when cooked, particularly suitable for English conditions. The variety Brown Dutch clearly occupies second place, with White Leviathan and Inépuisable of about equal merit.

Lastly, the production of haricot beans will normally be most successful in districts where fairly warm and dry conditions prevail. The north-eastern and northern areas should be avoided.

Seed. Supplies of seed of the white haricots are now available in this country.

Agricultural Machinery Testing Committee

Under the Ministry's Machinery Testing Scheme, the "*Perga*" Single Service Milk Container has been tested by the National Institute for Research in Dairying (University of Reading), Shinfield, Reading, to determine the bacteriological condition of cartons as received from the manufacturers, the bacterial content and keeping quality of milk in the cartons, the capacity of the cartons to hold milk without leakage, and the effect of the cartons on the flavour of milk.

The Official Certificate of Performance, together with the Report of the test (Certificates and Reports No. 71) have been published by His Majesty's Stationery Office, price 3d. net.

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Bulletin No. 37—Ensilage

The practice of ensilage in this country made a false start during the latter part of last century, owing to faulty methods, but during the past twenty years it has rapidly gained ground as the principles upon which it is based have become more widely known.

The Ministry's Bulletin* on the subject, written by Dr. Woodman, who contributes the informative *Hints on Feeding* to the JOURNAL, is a complete guide to modern methods, and includes chapters on suitable crops, on ensiling in pits, clamps, trenches, stacks and towers, on the chemistry of silage, and the method of using the product in the feeding of all classes of live stock.

RECENT AGRICULTURAL STATISTICS

Agricultural Index Number

MONTHLY INDEX NUMBERS OF PRICES OF AGRICULTURAL PRODUCE

(BASE, 1927-29 = 100)

Uncorrected for
Seasonal Variation

Corrected for
Seasonal Variation

Month	1938	1939	1938	1939
January	97	90	90	84
February	95	88	89	82
March	88	85	88	85
April	85	85	89	89
May	82	77	90	86
June	81	75	90	83
July	86	80	94	87
August	81	80	86	86
September	81	87	83	88
October	86	91	82	87
November	89	101	82	93
December	90	108	82	99

THE SAME, TAKING ACCOUNT OF PAYMENTS UNDER THE WHEAT ACT (a),
THE CATTLE SUBSIDY (b), AND GOVERNMENT PAYMENTS FOR MILK (c).

Month	1938	1939	1938	1939
January	99	95	93	89
February	97	93	92	88
March	91	90	91	90
April	88	90	92	94
May	84	82	92	91
June	83	80	92	88
July	88	85	96	93
August	84	85*	89	91*
September	84	92*	86	93*
October	91	96*	86	91*
November	94	105*	86	97*
December	94	112*	86	103*

(a) Commenced August, 1932. (b) Commenced September, 1934.

(c) Commenced April, 1934.

* Provisional.

* Obtainable from H.M. Stationery Office at the addresses given on the title-page of this Journal, price 1s. (1s. 2d. post free).

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ACREAGE UNDER CROPS AND GRASS, NUMBER OF WORKERS, and NUMBER OF LIVE STOCK, JUN 3, 1939,
ENGLAND AND WALES

	ACRES		No.
TOTAL ACREAGE under CROPS and GRASS (a)	24,613,261		
ARABLE LAND			
PERMANENT GRASS FOR HAY	8,034,598	Horses used for Agriculture (e)	545,921
" " NOT FOR HAY	4,611,554	Stallions being used for service	4,605
ROUGH GRAZINGS (b)	11,097,009	Unbroken Horses. One year and above	110,381
	5,066,083	" " Under one year	50,097
		Other Horses on Agricultural Holdings	131,850
		TOTAL OF HORSES	843,854
Wheat	1,682,636	Cows and Heifers in Milk	2,351,584
Barley	910,073	Cows in Calf but not in Milk	391,643
Oats	1,348,237	Heifers in Calf	450,977
Mixed Corn	83,344	Bulls being used for service	96,561
Rye	16,269	Bulls (including Bull Calves) being reared for service	44,595
Beans	159,795	Other Cattle. Two years and above	9,458
Peas	125,483	" " One year and under two	1,345,913
Potatoes	451,327	" " Under one year	1,241,655
Turnips and Swedes	395,999	TOTAL OF CATTLE	6,779,145
Maize	299,936	Ewes kept for Breeding (f)	8,637,240
Sugar Beet	337,060	Rams and Ram Lambs to be used for service	360,756
Cabbage for fodder, Kohl-rabi, and Rape	140,937	Other Sheep One year and above	1,021,085
Vegetables or Tares	49,568	" " Under one year	7,966,578
Lucerne	18,862	TOTAL OF SHEEP	17,985,659
Other Cereals (c)	47,212	Sows kept for Breeding	448,741
Orchards (d)	251,610	Boars being used for service	30,002
Clover, Sainfoin, and Grasses under Rotation for Hay	1,301,470	Other Pigs Two months and above	2,118,497
Other Crops	767,803	" " Under two months	387,861
Bare Fallow	252,904	TOTAL OF PIGS	3,315,101
	351,904		
	No		
Total Regular Workers	511,131	TOTAL FOWLS	52,811,135
Total Casual Workers	95,998	DUCKS OF ALL AGES	2,360,588
		GESE OF ALL AGES	533,655
		TOTAL TURKEYS	693,476
TOTAL ALL WORKERS (d)	607,129		

(a) Not including Rough Grazings
 (b) Includes Common Rough Grazings, which, following a special enquiry in 1938, were estimated to amount to 1,426,529 acres in England and Wales
 (c) Including Small Fruit in Orchards, (18,205 acres).
 (d) Excluding the occupier, his wife, and domestic servants.
 (e) Including Mares kept for breeding and Horses used by market gardeners
 (f) Includes two-tooth ewes

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ESTIMATED PRODUCE OF CERTAIN MINOR CROPS, ENGLAND AND WALES, 1939

Crop	Estimated Total Produce		Acreage				Estimated Yield per Acre		
	1939	1938	Total	Harvested ripe or as grain	Total	Harvested ripe or as grain	1939	1938	Average of the 10 yrs., 1929-1938
			1939	1939	1938	1938			
RYE ..	000's Tons 8.8	000's Tons 10.7	16,221	12,861	18,472	15,819	Cwt. 13.7 Tons	Cwt. 13.5 Tons	Cwt. 13.1 Tons
ONIONS ..	4.8	4.0	1,719	752	1,693	733	6.4 Tons	5.5 Tons	6.0 Tons
CARROTS ..	160.2	137.9	16,134		15,517		9.9	8.9	11.1
MUSTARD FOR SEED ..	10.9	10.5	23,551		23,703		Cwt. 9.3	Cwt. 8.9	Cwt. 8.5

Rye. The acreage in 1939 decreased by 2,251, to 16,221. Of this, 12,861 were harvested as grain, a decrease of 2,958 compared with 1938. The estimated yield per acre in 1939 showed an increase of 0.2 cwt. over that in 1938, and was 0.6 cwt. above the average of the ten years 1929-1938. In spite of the increased yield per acre, the decreased acreage resulted in the production falling from 10,700 tons in 1938 to 8,800 in 1939, a decrease of 18 per cent.

Onions. Of a total acreage of 1,719 in 1939, 752 were harvested ripe. The position shows little change from 1938 when 733 acres were harvested ripe out of a total acreage of 1,693. The yield per acre in 1939 was greater by 0.9 tons than in 1938, and was 0.4 tons more than the average yield for the previous ten years. Production of onions increased by 800 tons to 4,800 or by 20 per cent.

Carrots. The acreage in 1939 was greater by 617 acres than in 1938, when a total of 15,517 acres was reached. The yield per acre increased to 9.9 tons in 1939 as against 8.9 tons in 1938, but was 1.2 tons per acre less than the average of the ten years 1929-38. Production increased by 22,300 tons from 137,900 tons in 1938 to 162,000 tons in 1939 or by 16 per cent.

Mustard for Seed. The acreage decreased by 152 to 23,551 in 1939. The yield at 9.3 cwt. per acre was, however, 0.4 cwt. greater than in 1938 and was 0.8 cwt. more than the average of the previous ten years. Production increased from 10,500 tons in 1938 to 10,900 in 1939, or by 4 per cent.

RECENT OFFICIAL PUBLICATIONS

The Ministry's Advisory Publications. Since the date of the list published in the December, 1939, issue of this JOURNAL (p. 705), the undermentioned Advisory Publications have been issued by the Ministry.

BULLETINS:

No. 118.—Report on Insect Pests of Crops in England and Wales, 1935-7. 1s. (1s. 2d. post free).

Records in a summarized form, the incidence of the more important pests of agricultural and horticultural crops during the years 1935-7. Compiled for reference purposes and intended primarily for the use of economic entomologists.

Copies of the above are obtainable at the price mentioned from the Sales Offices of H.M. Stationery Office or through any bookseller.

RECENT OFFICIAL PUBLICATIONS

ADVISORY LEAFLETS :

No. 52.—The Suppression of Weeds. (Revised.)

No. 162.—Angora Rabbit Wool Production. (Revised.)

Copies of any of the above-mentioned leaflets may be purchased from H.M. Stationery Office, York House, Kingsway, London, W.C.2, or at the Sale Offices of that Department at Edinburgh, Manchester, Cardiff, and Belfast, price 1d. each net (1½d. post free), or 9d. net per doz. (10d. post free).

Single copies of not more than 20 leaflets may, however, be obtained, free of charge, on application to the Ministry. Further copies beyond this limit must be purchased from H.M. Stationery Office, as above.

A list of the Ministry's publications, including bulletins and leaflets on agriculture and horticulture, may be obtained free and post free on application to the Ministry.

" GROWMORE " LEAFLETS :

To supplement the ordinary Advisory Leaflets and to provide essential advice to agriculturists on their war-time problems, a special series of "Growmore" Leaflets is now being issued. Single copies of any of the leaflets listed below may be obtained free *on application to the Ministry only* (copies are not obtainable from H.M. Stationery Office). The following additions to the list published in the December JOURNAL have now been issued :

No. 13.—Linseed as a Home-grown Crop.

No. 14.—Poultry Rations in War Time.

No. 15.—Early Bite.

No. 16.—Woodpigeon Shooting.

No. 17.—Wheat Sowing in Late Winter and Spring.

No. 18.—Cereal Varieties for Spring Sowing : with particular reference to Wales and the West Country.

No. 19.—Sheep Feeding.

NOTICES OF BOOKS

Vegetable Culture. By H. C. Davidson. Pp. viii + 144. (London : Technical Press, Ltd. 1939. Price 2s. 6d.)

This little book, written in simple language and illustrated with sketches, is a useful contribution to the current literature on vegetable crops for garden cultivation. The author has dealt in a practical way with the whole range of vegetables suitable for cultivation in the British Isles and has indicated the approximate food value of each—a useful feature, particularly at the present time. The volume closes with a concise calendar of routine operations, which should be of assistance to many of those who are attempting the growing of vegetables on allotments and in gardens for the first time.

Cooking in War Time. By Ambrose Heath. Pp. 128. (London : Nicholson and Watson. 1939. Price 2s. 6d.)

This volume provides helpful suggestions in many directions for making the most of the war-time food market. A number of economical recipes and menus are given, and such subjects as food values, fruit and vegetable preservation, and uses of the chafing dish and hay box are dealt with attractively and practically. The cheerful good sense of this handy publication is not the least of its merits.

NOTICES OF BOOKS

The Land Our Larder. By G. Godwin. Pp. 127. (London: Acorn Press. 1939. Price 3s. 6d.)

It has been recognized with concern, by those acquainted with the land, that in the past two decades the fertility of our soil has not been maintained. A state of war brings home very forcibly the importance of having land in high condition. Land fertility is national capital and real wealth. The account given in this book of an experiment in land restoration at Surfleet, Lincolnshire, in which the Indore compost system plays an important part, is interesting and opportune. Moreover, it introduces in part a fresh outlook and in part a reversion to the old-fashioned attitude towards the maintenance of soil condition. And if it is somewhat unnecessary to describe the process as a dynamic agricultural enterprise, this does not detract from the honest purpose of attempting to establish a balanced system of farming to maintain the land in "good heart."

The Management of Farm Woodlands. By Cedric H. Guise. Pp. x + 341 (London: McGraw-Hill. 1939. Price 20s.)

This book is one of the American Forestry Series and is written primarily for students; and owners of farm woodlands and forestry estates in eastern United States. It will be, however, of interest to all concerned with the management of woodlands and the problems of afforestation.

Brucellosis in Man and Animals. By I. Forest Huddleson. Pp. xxi + 339 Illus. (New York: The Commonwealth Fund and London: Oxford University Press. 1939. Price 19s.)

Bovine contagious abortion is one of the outstanding sources of loss to the cattle industry in this country, and a publication by Dr. Huddleson, an American veterinarian who has spent some twenty years in the study of this disease and others of the same group, will necessarily be read with interest and profit. The general balance of this book is reflected in the fact that, whilst some 50 pages are given to the more essentially laboratory aspects, and 180 pages to the disease in human beings, only some 80 pages are given to the disease in animals. The author has, in fact, according to his preface, refrained from dealing in any detail with the results of field investigations (as regards vaccination, eradication, etc.) on animals, and this book will therefore be of somewhat less appeal to those concerned with animal health than would have otherwise been the case. Notwithstanding this, Dr. Huddleson's book is one which may be read with interest by all who are at all closely connected with brucellosis.

Gardening Without Soil. By A. H. Phillips. Pp. 137. Illus. (London: C. Arthur Pearson, Ltd. 1939. Price 3s. 6d.)

This work is offered by the author as a stepping-stone between the scientific and practical aspects of the culture of plants in nutrient solutions, and as such is a welcome addition to horticultural literature. It is an adequate and accurate popularization of the subject, in which the right note of warning is sounded.

The extravagant claims of imaginative writers, particularly in America, is condemned by the author, whose attitude is plainly stated as being that, while no better crop results are obtainable than under ideal soil conditions, ideal conditions are both more expensive and difficult to obtain and maintain.

The thesis that plants may be grown to maturity in nutrient media is not questioned; but it is unfortunate that no evidence is offered on the comparative costs of production under soil and soilless conditions in which the cost of plant and saving of labour are contrasted with digging, and

NOTICES OF BOOKS

partial sterilization. Possibly the most vital criticism of the method must centre round the degree of control available. Malnutrition through impurities in the chemicals used or errors of dilution and temperature might be expected to be reflected in all the plants grown, whereas by the soil method, the soil itself acts as a "buffer" and tends to minimize the effect of errors.

The great value of the method would appear to lie in the field which it opens up for the extension of food production under arid conditions.

The Status and Distribution of Wild Geese and Wild Duck in Scotland. (International Wildfowl Inquiry, Vol. II.) By John Berry. Pp. xiii + 190. Illus. (Cambridge: University Press. 1939. Price 10s. 6d.)

This is the second volume of a work which represents the first attempt to compile a distributional index and a practical numerical estimate of the stock of wildfowl inhabiting any given area of the world. For some time past the decline in the numbers of wildfowl has caused serious concern, but before adequate measures (if, indeed, such are possible) can be taken, it is obviously necessary to know the true position and to appreciate the factors contributing to it. This survey is all that has been claimed for it. Some of the information disclosed is disquieting, and it is plain that as far as Scotland is concerned the survey was badly needed. The names of Dr. John Berry as author, and the Misses E. V. Baxter and L. J. Rintoul as collaborators, are sufficient guarantee of the reliability of the recorded observations and the conclusions reached.

In a foreword, Dr. P. R. Lowe expresses the opinion that this work is a model on which all future estimates for Scotland will be based, and there will be no disagreement with his verdict. Indeed, it might well serve as a model for all future works of the kind, wherever undertaken.

Growing Plants Without Soil. By D. R. Matlin. Pp. 137. (London. Spon. 1939. Price 11s.)

This trans-Atlantic addition to the flood of quasi-popular literature on the growing of plants in nutrient solutions devotes nearly 70 of its 137 pages to such subjects as: What to Plant at the Seashore and in the Mountains; Garden Pests of California; Flower, Bulb and Vegetable Calendars for Southern California; List of American Experimental Stations, Analysis of Los Angeles Water, etc., etc. The main subject to which the title purports is explained in a simple and easily intelligible manner.

Dairy Cattle and Milk Production. By C. H. Eckles. 3rd Edition. Pp. xv + 520. Illus. (New York and London: Macmillan. 1939. Price 18s.)

This American manual deals comprehensively with the selection, breeding, feeding and general management of dairy herds in a country where dairy farming is spoken of as "the two-billion dollar industry," and forms the major source of the farming income. It is interesting to note that dairy cattle in the U.S.A., though primarily kept for milk production, furnish nearly one-half of the country's beef supply, and that the working life is only five lactations, compared with seven stated by the author to be customary in Denmark.

A striking omission in the view of English readers is that of any adequate treatment of the subject of Clean Milk Production: the words "hygiene," and "cleanliness" do not appear in the index. An important section is that dealing with rations, including silage and the production of soiling crops.

NOTICES OF BOOKS

Food Values at a Glance. By V. G. Plimmer. Pp. 190, with 41 tables and coloured charts. (London: Longmans, Green. 1939. Price 6s.)

This new edition was prepared in the author's belief that a war was imminent, and in the knowledge that food is the first line of defence against physical disease, and, in war time, against the enemy. As a further and even wider inspiration, she would "have none live in poverty, straits or sorrow." Valuable facts relating to food have been patiently gathered from the columns of figures in which they usually lie buried, graphically presented for quick reference and easy understanding, to provide a readable and reliable guide to the complex science of nutrition.

British and Irish Writers on Agriculture. By W. Frank Perkins. Pp. xi + 226. (Lymington: Charles T. King. 1939. Price 12s. 6d.)

For this new edition, the 3rd, the author has added nearly 500 entries, compiled a subject index and a list of periodicals relating to agriculture up to the year 1900, all useful embellishments of a work that has already gained some reputation.

Milk Investigation Scheme. Costs of Milk Production in England and Wales. Interim Report No. 4, October, 1937, to September, 1938. Pp. 53. (Oxford: Agricultural Economics Research Institute. 1939. Price 1s. 6d.)

Most of this report deals with the costs of production on 409 farms selling milk mainly on wholesale contracts (wholesale group), but it includes the figures of 81 producers of Grade A (T.T.) and Certified milk (graded group), and of 50 producer-retailers (producer-retailer group); and deals also with a number of other factors affecting the cost of milk production, such as production for level delivery and of accredited milk, the influence of size of herd, the effect of yield, and the costs on farms with and without milking machines.

Wild Foods of Britain. By Jason Hill. Pp. 94. (London: Black. 1939. Price 2s. 6d.)

Mr. Jason Hill's very interesting and useful little book on our British wild foods should be in the hands of every country housewife, and of countrymen generally. Not only does he give an accurate description with good figures of many of our wild plants, including Algæ and Fungi, but also gives a full account of the edible parts, their flavours and dietetic value. Short chapters deal with Flesh and Fowl, Fish, Molluscs and Tisanes, which are well worth being better known in this country. There is also a useful chapter on what should be avoided. Quite the most valuable portion of the book is that in which he gives recipes for the use of the various plants referred to, and one is filled with a desire to partake of such things as Nettle Purée, Laver, which is an excellent vegetable, Caragheen Mould, Hazelnut bread, Elderberry flowers and fruits, and many others.

In dealing with the edible Fungi, Mr. Hill refers to the Ministry's Bulletin No. 23 on Edible and Poisonous Fungi. His criticism of the Blewit as one of the too highly coloured plates of some of the other fungi is unfortunately justified, but in the new edition, now in the Press, these defects—mainly due to the method of reproduction—have been rectified and some new plates, including the Blewit, have been substituted.

One great merit of the book is that the author has made personal trial of all he recommends. His rabbit recipe is well worthy of trial.

I.A.R.I. 75

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